

SPECIAL PUBLICATION No.1

**Proceedings of the Symposium
on Intraspecific Variations**

Zoological Survey of India, Calcutta

ZOOLOGICAL SURVEY OF INDIA

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**Proceedings of the Symposium on Intraspecific Variations
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P R E F A C E

The study of intraspecific diversity is one of the most active aspects in our understanding of species dynamics. Species comprise natural populations and the occurrence of a wide range of variations within species, often influenced by distribution, micro-habitat, as well as a wide host range, not to mention of genetic factors, have made the study of individual species very difficult, requiring examination of a large series of individuals from diverse habitats. As such morphological and physiological characters, patterns of geographical distribution and ecological and genetic diversity are contributory factors for variation within species. In order to appreciate the need for a proper understanding of the degree of intraspecific diversity in some groups of insects a mini-symposium was held by the Zoological Survey of India at Calcutta, when an attempt was made to discuss at length, problems associated with intraspecific diversity of some species belonging to the orders Diptera, Homoptera, Isoptera, Phthiroptera, Thysanoptera, Dermaptera and Coleoptera. A collection of some of the more important papers presented in this volume, I am sure, would lead to an appreciation of the need for a proper understanding of the degrees of intraspecific diversity and therefore of the species dynamism.

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ASPECTS OF INTRASPECIFIC DIVERSITY IN RELATION
TO THE *LACCA* COMPLEX OF INDIAN LAC INSECT
(HOMOPTERA : TACHARDIIDAE)

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The commercial lac (shellac) is produced by the females of a tropical species of coccids, *Kerria lacca* (Kerr). It thrives on a number of host-plant species and is widely distributed in India and neighbouring countries. On account of its economic importance, it was introduced with stocks from India in many other countries like Sri Lanka, Malaysia and Taiwan where it has since established, and in Egypt where it could not. Attempts have been made to grow it in parts of U.S.S.R. with stocks from South China.

Genus *Kerria* Targ. is known presently by 17 species, out of which all but one are distributed in South and South East Asia (Varshney, 1976). Whereas these all species are known to secrete true lac, i.e. resin soluble in alcohol, *lacca* alone has been cultivated extensively to produce bulk of lac in major lac growing areas.

This species has been referred by different scientific names in the past. A synopsis of taxonomic citations for the genus and species group names is provided in Table I. It was first described as *Coccus lacca* by James Kerr in 1782. Fabricius's name *Coccus ficus* given to it was synonymized by Blanchard in 1883.

Out of many species proposed for Indian lac insects by Mahdihassan (1923), *Lakshadia indica* was instantly synonymized with *lacca* by Chamberlin (1925). Lindinger (1933) has shown that Goeze's name *gummilaccae* for it, although proposed earlier than *lacca*, is not valid and therefore *lacca* is the oldest valid name applied to this species.

ONE OR A COMPOSITE SPECIES ?

There is reason to believe that in most of the earlier literature on Indian lac, the species of the lac insect was reported *lacca*, without actual taxonomical examination of the population concerned. In fact some of the applied entomologists and workers on lac thought it convenient if the Indian lac insects are restricted to only one species. Beeson (1924) stated, "It may be said that from the economic aspect of the problem the lac cultivator is not assisted greatly by the knowledge the *Tachardia lacca* is on the one hand a single species, or is on the other hand a group of morphologically similar species. However in regarding it as one species he will be supported by the majority" Glover (1937) opined that the lac insect in major lac growing areas is actually

one species, *lacca*, and that many of the species of the genus *Laccifer* (now *Kerria*) which have been designated are almost certainly strains or at the most varieties of *lacca*.

On the other hand insect taxonomists have considered *lacca* a polyspecies. Green found it "a peculiarly polymorphic species, of which the extreme forms might well be regarded as distinct species" and ranked his species *Tachardia fici* as merely an extreme form of *lacca*. During Third Entomological Meeting held at Pusa in 1919, C.S. Misra informed T.V. R. Ayyar that there are a number of species of lac insects in India and *lacca* is one of these. Mahdihassan (1923) went to the limit of replacing *lacca* by proposing 6 separate new species of Indian lac insects, on the basis of so called 'physiological standpoint'. While criticizing Mahdihassan's approach, Chamberlin (1925) agreed, "It is quite possible and indeed probable, that *lacca*, with further study of abundant and fresh material will be found to split up into a number of local races or sub-species." He, however, himself separated a number of new species including *Tachardia ebrachiata*, which is almost similar to *lacca* except sessile branchia.

Later, Takahashi (1941), A.B. Misra (1930) and Varshney (1976) have reported new species from populations cultivated for production of lac. Roonwal (1958) has clearly stated about *lacca* that "it is evidently a composite species and when better studied will almost certainly be found to be composed of several distinct subspecies and probably even species"

As such *K. lacca* is a very interesting polymorphic species. Some of the observations on these aspects were reported earlier (Varshney, 1964) and an attempt is made in this article to present and discuss in brief the intraspecific variations in the structure and behaviour of this species complex.

1. MORPHOLOGICAL VARIATIONS

1.1. Structural :

Females of *K. lacca* are characterized with following chitinous characters [see Fig. 1 (A) for terminology]: Anal tubercle distinctly longer than broad; branchia long, elevated, without any constriction with body wall; branchial crater having 9—12 shallow dimples; anterior spiracles larger in area than branchial plate and fused with the branchial base of its side; distance between branchial plate and anterior spiracle significantly far; dorsal spine long, with bulging pedicel; perivaginal pore clusters 6—9 on each side of anal tubercle; marginal duct clusters 6, each with 25—40 ducts arranged convolutedly; antennae small with indistinct segmentation and 3—4 minute apical setae. Mounted body measuring 2.9—3.3 mm in length and 2.6—2.8 mm in width (Varshney, 1976).

Both alate and apterous forms are found in the male insect, but males have been kept outside the purview of this article.

TABLE I. Synopsis of scientific names applied to the Indian lac insect

Genus **Kerria** Targioni-Tozzetti, 1884

1815. *Laccifer* Oken, *Lehrb. der Naturgesch.*, 3 (1) : 430 [Rejected].

1874. *Carteria* Signoret, *Ann. Soc. ent. France*, (5) 4 : 101 [Preoccupied].*

1884. *Kerria* Targioni-Tozzetti, *Ann. di Agr. 1884, Min. di Agr. Ind. e Com. Italy* : 410.

1886. *Tachardia* Blanchard, *Zool. Med.*, 1 : 1 [Synonym].

1923. *Lakshadia* Mahdihassan, *J. Sci. Asso. Mahar. Coll., Vizianagaram*, 1 (2 & 3) : 87. [Synonym].

K. lacca laaca (Kerr, 1782) Varshney, 1966

1778. *Coccus gummilaccae* Goeze : Lindinger, 1933, *Ent. Ztschr.*, 46 (21) : 228 [nom. oblitum].

1782. *Coccus lacca* Kerr, *Phil. Trans. R. Soc. London*, 71 (2) : 374.

1787. *Coccus ficus* Fabricius, *Mant. Ins.*, 2 : 319. [Syn.]

1923. *Lakshadia indica* Mahdihassan, *J. Sci. Asso. Mahar. Coll. Vizianagaram*, 1 (2 & 3) : 60 [Syn.]

1966. *Kerria lacca* (Kerr) : Varshney, *Indian J. Ent.*, 28 (1) : 118.

As stated above, Green considered *fici* as an extreme form of *lacca* (cf. Chamberlin, 1923). At the present state of knowledge, this, however cannot be agreed to. True that both *lacca* and *fici* are common and widely distributed in India and eastern countries and they have certain common host-plants, yet all systematists have treated them as two distinct species. The present author has separated series of specimens from different populations of these two, on the basis of following characters in *fici* : (i) broader than long anal tubercle plate ; (ii) short branchia with well sclerotized large and wide branchial plates ; (iii) lesser number of branchial dimples, generally 4—5 ; (iv) with 40—50 ducts in each marginal duct cluster ; and (v) comparatively longer antennae.

Chamberlin (1923) has distinguished morphological characters of *lacca* very well, but he too provided a little handle to consider *lacca* a polyspecies. One, that his new species *ebrachiata* in his own words is very close to *lacca* except its sessile branchia, and two, that if in his account of *fici* the ratio of length and width of supra anal plate (anal tubercle) is given lesser importance, than *fici* will occupy a much closer place with *lacca*.

A. B. Misra (1930) proposed 6 new species : *ambigua*, *indica* (= *indicola* Kapur), *jhansiensis*, *longispina*, *kydia* and *pusana*. On study the present author has found that *longispina* is a synonym of *chinensis*, and three others *ambigua*, *jhansiensis* and *kydia* have been relegated to the status of mere subspecies of *lacca*, *fici* and *chinensis* respectively (Varshney, 1976). Misra described these species on differentiation in size of branchia and spine and provided vague and insufficient descriptions. Besides his observations were based on probably a very small collection which is now not traceable. These species are known from their original record only to date.

In this matter of giving specific rank on account of small differences in lengths and breadths of anal and branchial tubercles, or on account of shape of insect, or difference in secreted resin amount, Negi (1934) has put forward some thoughts, which are worth reproducing, "Owing to the deposition of resin, the shape of the adult female lac insect either takes the form shown in figure 1 (B) or 1 (C). The latter represents the shape of those insects which grow more or less separately, without coming into very close contact with one

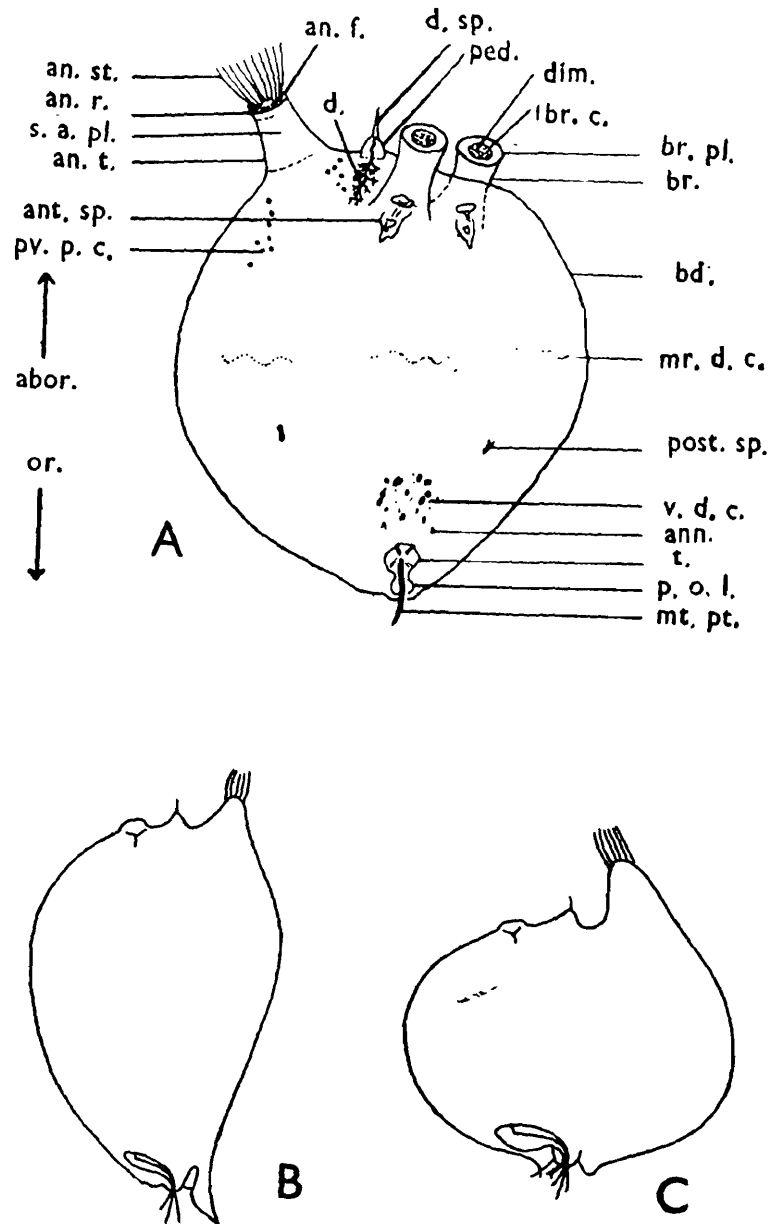


Fig. 1 (A-C) : Different orientations of female lac insect, *Kerria lacca* (Kerr) [A, after Varshney, 1976; and B & C redrawn after Negi, 1934].

abor. = aboral side, or. = oral side, an. f. = anal fringe, an. st. = anal setae, an. r. = anal ring, an. t. = anal tubercle, s. a. pl. = supra anal plate, pv. p. c. = perivaginal pore clusters, ant. sp. = anterior spiracle, post. sp. = posterior spiracle, d. sp. = dorsal spine, ped. = pedicel of spine, d. = duct of spine, br. = branchium, br. pl. = branchial plate, br. c. = branchial crater, dim. = dimples, mr. d. c. = marginal duct cluster, v. d. c. = ventral duct cluster, ann. = antenna, t. = tentorium, mt. pt. = mouth parts, p. o. l. = post. oral lobes, bd. = body wall.

another. The former shape is assumed by insects which coalesce or overlap. In the females of the type shown in fig. 1 (C) the rostrum [mouth parts, proboscis] is situated ventrally at about the middle of the insect, whereas in those of the other type shown, it is situated at the extreme anterior end. In the females of the intermediate shapes, the rostrum lies ventrally in the anterior half of the body. In such females [fig. 1 (C)] the rostrum lies almost at a right angle to the other mouth parts and the crumena lies opposite to the tentorium and the mouth parts enclosed in it. But in the females of the type represented by fig. 1 (B) the direction of the tentorium and the mouth parts enclosed in it is totally changed; the hind end of the tentorium is directed towards the anal end of the female, and the rostrum lies in the front of the tentorium at an obtuse angle and the crumena lies over the tentorium". It is obvious that Negi (1934) and later Glover (1937) have rightly warned against having such species of lac insects on the criteria of shapes and sizes of different body parts. The rostrum, however, is not considered a taxonomic character presently.

Nevertheless, study of more material labelled as *lacca* was bound to lead in the discovery of other unknown species. Takahashi (1941) described a new species *siamensis* from Thailand, from a single specimen not in good condition. Mahdihassan (1952) has claimed that it is a synonym of *chinensis*. But it appears that he has not compared his specimens with the type of *siamensis*. Such an examination is very desirable before effecting the synonymy. Unfortunately, neither the types of *siamensis* nor of *chinensis* and other spp. proposed by Mahdihassan, are traceable presently.

Varshney (1976) has described *chamberlini* from yellow females collected from Rajasthan, *branchia* from Bihar, and *nepalensis* from Indo-Nepal border area. Structurally they all provide distinct characters to separate them from *lacca* and other known species, as already indicated therein. Besides, for the first time, 4 subspecies have been recognized under *lacca*, viz., *l. lacca*, *l. mysorensis* and *l. ambigua* from India and a new subspecies *l. takahashii* from Thailand. A key to these subspecies has also been put therein.

1.2. Colour forms :

Ordinarily *lacca* insects are of crimson or red colour, on account of a red dye present in their body fluid. But sometimes yellow colonies of lac insects are also come across. Such yellow lac insects have been reported in various species, viz., *albizziae* (Green, 1922), *fici* (Mahdihassan, 1953), *lacca* (Gupta, 1953; Negi, 1954), *chamberlini* (Varshney, 1976). The yellow colour of female body has not been found to be of taxonomic significance. Chauhan (1967) has reported yellow insects as mutants. These yellow *lacca* insects, often referred as *K. lacca* 'yellow' variety, do not differ morphologically from the 'red' variety and they are found to follow the *Rangeeni*

life cycles (vide infra) in most of the cases. Yellow females give yellow offsprings, but usually the new generation after settlement on host-plants change to 'red' during their metamorphosis. Cross breeding experiments in between 'yellow' and 'red' varieties have shown that these can easily inter-breed. The yellow insects have so far been reported from Rajasthan, Delhi and Jammu-Kashmir. No natural yellow colonies have been reported from South, Central and East India.

Chauhan & Teotia (1973) have reported a 'white' coloured population of *lacca* for the first time. Morphological details of these 'white' females have not been reported so far. It has, however, been determined as a simple recessive mutant. The 'white' lac insect has colour neither in the body fluid nor in the lac resin secreted.

2. BIOLOGICAL VARIATIONS

Biologically *lacca* leads 4 kinds of life cycles, which can be grouped into two major kinds, the *Rangeeni* and the *Kusumi* (see Table II). Insects thriving on Kusum host-plant (*Schleichera oleosa*) or on other trees or bushes inoculated with Kusum broodlac, complete their life cycle in approx. 6 months each: summer crop from Jan-Feb. to June-July, and winter crop from June-July to Dec.-Jan. Insects thriving on host-plants like Palas (*Butea monosperma*), Ber (*Zizyphus mauritiana*), Pipal and Barh (*Ficus* spp.) and plants other than Kusum, also complete two life cycles a year, but one of 4 months: rainy season crop from June-July to Oct.-Nov.; and other of 8 months: Summer crop from Oct.-Nov. to June-July. Because of this varied biological behaviour, the two bivoltine broods are referred as '*rangeeni*' and '*kusumi*' strains or forms. The terms *rangeeni* and *kusumi* seem to have been first put into use in the lac literature probably by C. S. Misra in 1919 and they have since well established in the lac industry, from the tribal cultivators to the export market. Although these strains provide insignificant morphological differences, they secrete quite different quality and quantity of lac resin. The *rangeeni* lac is produced more, but is of inferior quality, while the *kusumi* lac is produced less but is of superior quality and fetches better price.

2.1. Trivoltine and other irregular life cycles :

Aside the two life cycles per year, as reported above in most of the lac growing areas of India, a 'trivoltine' strain of lac insect was reported from Mysore (now Karnataka), which was grown on *Shorea talura* trees, locally called Jallari. This insect was reportedly passing three life cycles in 13 months. Mahdihassan (1923) referred to it as 'Mysore lac insect' or '*Shorea talura* insect' and named it as *Lakshadia mysorensis* (now *K. lacca mysorensis*).

This unusual life cycle of trivoltine strain seemed to depend on the climatic conditions and other natural factors of that area, because as Glover

TABLE II. Month-wise depiction of different life cycles of the Indian lac insect, *Kerria lacca*. in major lac growin areas (*after* Varshney, 1972)

Strain	Crop	J	J	A	S	O	N	D		M	A	M	J	J
Rangeeni	Katki :													
	Baisakhi :													
Kusumi	Aghani :													
	Jethwi :													

(1937) reported that when a consignment of the Mysore trivoltine insect was brought to Namkum (Bihar) and grown on the same tree *Shorea talura*, it did not pass through three cycles in the year but only two.

Similarly it was strange to know that the progeny of *kusumi* broodlac from Bihar had no definite life cycle period on Kusum trees in forests of Madurai Distt. (Tamil Nadu). It completed life cycles in different months every succeeding year, perhaps due to climatic conditions of that area (Negi, 1954).

In the opinion of the present author, a fresh trial of such irregularly behaving populations, under carefully controlled conditions, is desirable to ascertain and elucidate the causes and nature of these variations.

2.2. *Parthenogenesis in lacca* :

Parthenogenesis was considered effective in *lacca* females by earlier workers (Glover, 1937 ; Negi, 1954 ; Kapur, 1962). Recent workers however, found it to be not true. The virgin females lived generally longer than their mated sisters, showed poor development but eventually died without issuing any larvae. The fact has been first reported by Teotia & Chauhan (1964), and since confirmed by many other workers including the present author, on careful breeding of the lac females on suitable host-plants under fine mesh sleeve cages. Hence, it is not expected that parthenogenetic forms of *lacca* exist.

3. PHYSIOLOGICAL VARIATIONS

Mahdihassan (1923) classified Indian lac insects into 7 new species (*Lakshadia indica*, *L. nagoliensis*, *L. chiensis*, *L. mysorensis*, *L. sindica*, *L. communis* and *Tachardia silvestrii*) on what he called a physiological standpoint. He based it on the nature of lac secreted, the different chemical and physical properties of the lac, the process of secretory activity, and the insect parasites, predators and symbiotes associated with them. Whereas his taxonomical findings have been thoroughly criticized and rightly so, there is no doubt that Mahdihassan should get the credit of probing into *lacca* complex, realising its polymorphic nature, more than 50 years ago. His *Tachardia silvestrii* is now placed in a separate genus *Paratachardina* Balachowsky. The lac secreted by it is hard, brittle and insoluble in alcohol.

While host specificity is clearly established in *kusumi* populations of *lacca*, and in *K. nagoliensis* which is a species inquirenda, host preferences are known for *rangeeni* insects of *lacca* and for a few other *Kerria* species. More than 400 plants have been listed on which *lacca* and its sister species have been reported from India and adjacent countries (Roonwal *et al.*, 1958 ; Varshney & Teotia, 1967). However, *lacca* is cultured only on a handful of plant species for commercial purposes. Among the above referred two

strains, it has been observed that when *rangeeni* insects, for example of Palas brood, have been inoculated on Kusum trees, they could not establish successfully. It can only be explained due to the physiological upset in the nutritional requirement of the strain concerned. This assumption is supported by genetic breeding experiments of Chauhan & Mishra (1970). They observed that while *rangeeni* insects had negligible survival on kusum trees, the hybrid progeny survived almost as well as *kusumi*. The factors responsible for this physiological variation are yet to be specified. It may be added that the constitution of phloem sap of lac host-plants, which these insects suck as food, is not known as yet. Host specificity, however, is not strictly followed, as some of the plants like Ber (*Zizyphus mauritiana*), *Albizzia lucida* and *Moghania macrophylla* can act as host for both the *rangeeni* and *kusumi* forms of *lacca*.

Certain sporadic biochemical studies have been made on these insects in recent times. Distribution of alkaline phosphatase has been studied both in male and female lac insects at different metamorphic stages (Gupta & Haque, 1976). The detection of amino acids and sugars through chromatography in different stages of development, and the examination of body fluid dyes in ultra violet, have been carried out by the present author (unpublished). Such studies are likely to help in evaluation of nature and status of *rangeeni* and *kusumi* strains and may reveal other unknown aspects of *lacca* complex.

4. GENETIC VARIATIONS

Among the *lacca* females it was experimentally seen that there is a tendency for the larger females to mature some what earlier. The metamorphic increase in the size of a female is adjusted to accommodate the developing embryos and thus indicates the size of progeny produced (Chauhan, 1967a).

Cross breeding experiments in between 'red' and 'yellow' varieties, revealed that when bred among themselves, each variety produces young ones of their own colour. The crosses between 'red' and 'yellow' made in any way produced only 'red' larvae in F₁ generation, which when back crossed with 'yellow' produced original parental colour forms. The newly emerged lac larvae always retain their mother's colour irrespective of the colour of mated male lac insect (Chauhan, 1967).

In Jhalda (West Bengal), which is predominantly a *kusumi* lac growing area, it was curiously observed by the workers of Indian Lac Research Institute that some females of winter crop often matured earlier in Oct.-Nov. itself, instead of normal January period. This was referred as 'spurious emergence' of larvae. After breeding experiments in between males of *rangeeni* and females of *kusumi*, it was found that in F₂ generation whereas 80% females mature in January, the remaining 20% matured in November (Chauhan & Majumdar, 1967).

The chromosomal system of *lacca* has been studied by various workers, yet the cytological picture remains rather confused. Dikshith (1962) reported a diploid chromosome number of 18 in *kusumi* strain ; individual chromosomes appearing rod-like with minor variations in size. Teotia & Dikshith (1963) reported 18 chromosomes in the *rangeeni* strain also. Tulsyan (1963) interestingly reported that in males the chromosome number is 17 as against 18 in females and he indicated XX female XO male type mechanism in *lacca*. Dikshith (1964) contradicted findings of Tulsyan and reported diploid chromosome number 18 in both sexes (and in yellow insects : Dikshith, 1964a), with no sex chromosome. He reported the unorthodox 'Lecanoid' system in *lacca* with heterochromatization of one set of chromosomes in the case of male tissues and never in the female tissues. Chauhan (1970, 1977) provided cytogenetic evidence by breeding experiments, using colour and other marker genes, of an unorthodox system in *lacca*, stating that both the maternal and paternal chromosomes are somatically active in the male *K. lacca*. The heterochromatization and elimination of the paternal chromosome-set is confined to the male germ line. The *K. lacca* genes are thus autosomal in expression but sex linked in transmission. The studies are obviously interesting and require further attention.

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INTRASPECIFIC DIVERSITY IN *CLEPHYDRONEURA BREVIPENNIS* OLDROYD, *EPISYRPHUS BALTEATUS* (DE GEER) AND *ORTHELLIA COERULEA* (WIDEMANN) (DIPTERA)

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One of the most difficult and at the same time equally interesting problems of taxonomy is intraspecific variations or plasticity of species. Diptera as a whole does not exhibit much intraspecific variation when compared with some lowly evolved orders of Insecta. But the families Culicidae and Sciaridae are well known for their sibling species. In this paper, intraspecific variations exhibited by three species of flies belonging to three different families are dealt with.

***Clephydroneura brevipennis* Oldroyd (Fig.1A-C)**

It is one of the common members of the family Asilidae or robber flies. During December 1975—January 1976, we collected about 200 examples of this fly from Walayar Forest, South India. In majority of the individuals the

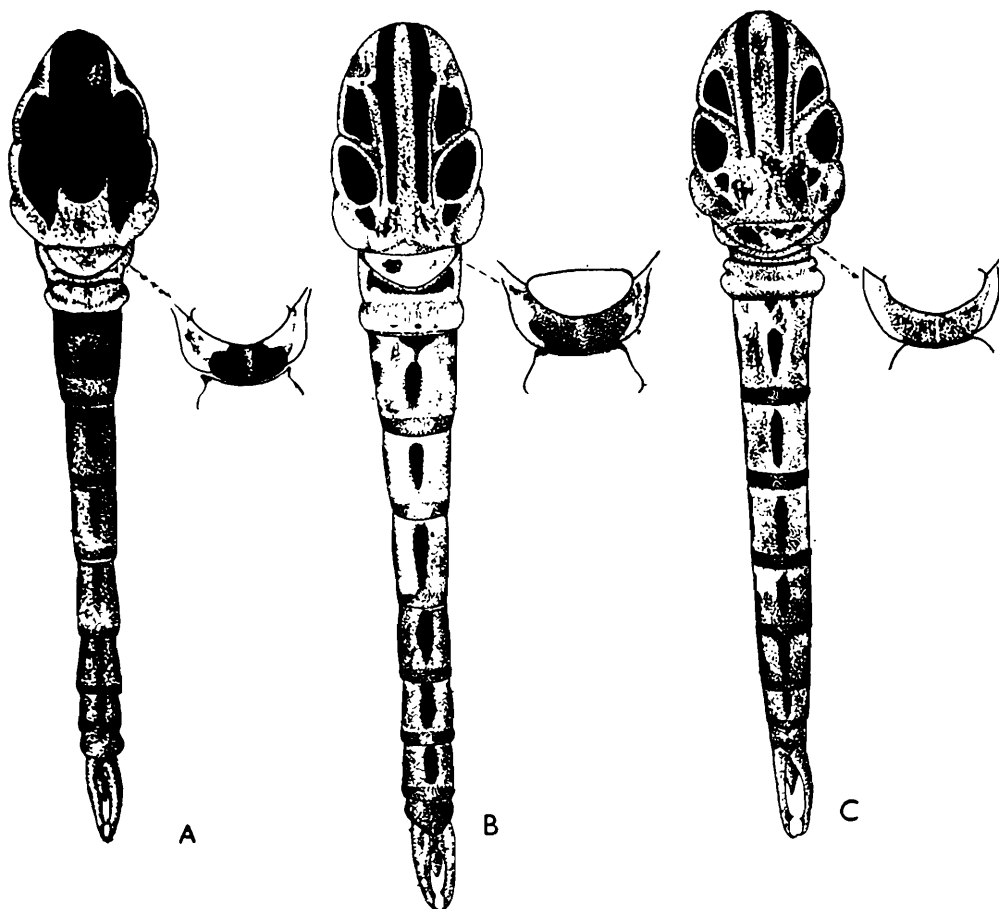


Fig. 1 A-C. *Clephydroneura brevipennis* Oldroyd, thorax and abdomen showing decreasing black colouration.

colouration of thorax and abdomen is 'as follows : mesonotum black but sides and hind part yellowish-brown or greyish-yellow, the black area with indistinct mediolongitudinal greyish lines : metanotum medially black for a considerable area and the rest yellowish-brown ; abdomen black except for the yellowish-brown distal half of tergum 1. In some examples there is a decrease in the area of black colour side by side with an increase in the yellowish-brown or greyish-yellow colour : mesonotum with a mediolongitudinal black stripe and three lateral black spots in row, of which the posterior one being the smallest, the stripe and spots separated by greyish-yellow, the median stripe in its turn being longitudinally divided by yellowish-brown ; metanotum with two lateral black spots and the rest yellowish-brown ; abdomen grey and black, on tergum 1 the intensity of black colour less side by side with an increase in grey or yellowish-grey area, tergum 2 with a median broken and two lateral broken black stripes, hind margin bordered by a transverse black band ; tergites 3 to 6 with one median and two lateral black stripes joining a hind transverse concolourous band, from 7 onwards almost wholly black. Some other specimens are still lighter coloured : mesonotum predominantly yellowish-brown or greyish-yellow with the black mediolongitudinal stripe narrower and the band dividing it broader and distinct, the lateral black spots smaller ; metanotal black colour much lighter and in the form of two folded mediolateral markings ; abdomen predominantly yellowish-brown, tergum 1 with an anterior dark shade, tergum 2 with a broken mediolongitudinal and two broken lateral black stripes, hind margin bordered by a transverse black band, tergites 3 to 7 or 8 with a mediolongitudinal and two lateral black stripes, the latter uniting with a transverse concolourous hind band, rest of abdomen black.

There are also some additional minute intraspecific variations exhibited by these flies : the moustache generally white but in two females two of the bristles black ; hairs on scutellar disc vary in colouration and length, usually black, in some examples mixed black and white, while in one case wholly white, hairs long but in one example less than half the usual length ; in females the number of ventral bristles of fore femora vary from 4 to 7 ; in both sexes the number of bristles of mid and hind femora vary from a few to many ; colouration of abdominal tergal bristles varies from wholly pale to mixed pale and black.

***Episyrphus balteatus* (De Geer) (Fig. 2A-F)**

It is a common flower fly belonging to the family Syrphidae. The National Collection of Zoological Survey of India possesses a huge collection of these flies from various parts of India. These flies exhibit variation in colouration and shape of abdomen. Usually the abdomen is marked with alternate transverse bands of yellowish-brown and black. There is a tendency to increase the breadth of black bands so much so in a few examples the

abdomen is black. It has not been possible to correlate this variation in colouration with altitude since we have specimens from high altitude of Arunachal Pradesh with increased blackening side by side with specimens from high altitude of Kashmir without this increase.

The abdomen of this flower fly is more or less of uniform breadth in the majority of specimens. At the same time it is seen that there is a tendency towards the widening of abdomen which takes place in two directions. In some examples there is a gradual widening from the first to second or from the first to third from where there is a gradual narrowing. Yet in a few other

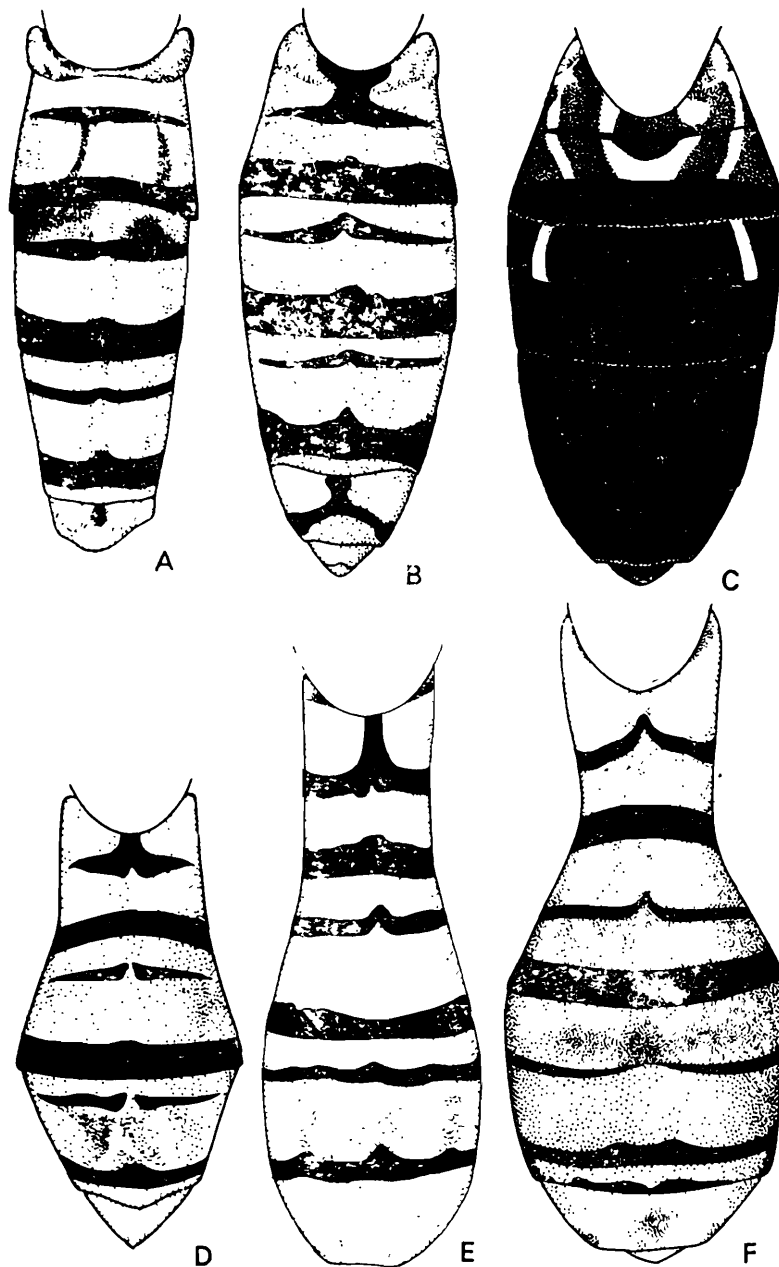


Fig. 2 A-F. *Episyrphus balteatus* (De Geer) : A-C. abdomen showing increasing black colouration ; A, C showing the widening of abdomen from segments 1 to 2 ; A, D, showing the widening of abdomen from segments 1 to 3 ; A, E, F, showing the widening of abdomen at the posterior side.

examples the widening is towards the posterior side of the abdomen and in the extreme cases the distal part is almost double the breadth of base.

***Orthellia coerulea* (Wiedemann) (Figs. 3A-C & 4A-D)**

This fly is a common member of the family Muscidae, which exhibits variation in compound eyes, venation and abdomen. The ommatidia of compound eyes are of uniform diameter in this fly. However, a tendency to increase in the diameter of ommatidia of compound eyes is noticeable in the

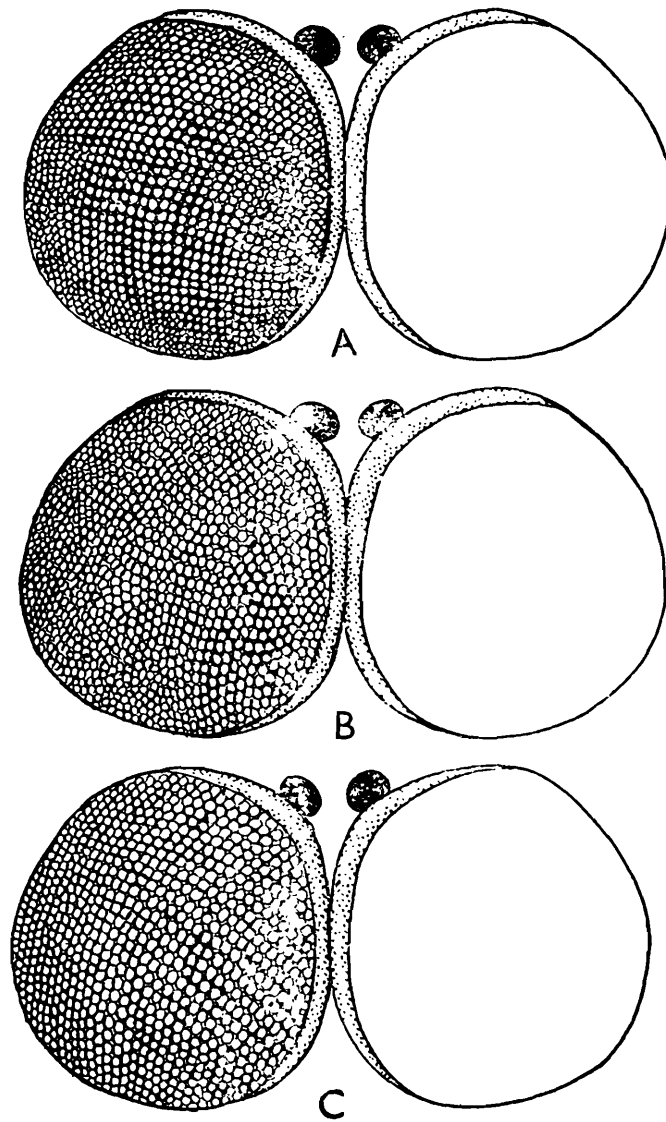


Fig. 3 A-C. *Orthellia coerulea* (Wiedemann), compound eyes showing increasing diameter of ommatidia.

males. But in the case of a number of specimens collected from the high altitude of Arunachal Pradesh the diameter of most of the ommatidia is double, which is more frequent in case of males. There is a series of specimens from Arunachal Pradesh showing the enlargement of a few ommatidia to the extreme cases wherein most of them are enlarged.

Considerable variation is exhibited in the shape of m-m cross-vein, from the nearly straight to much curved condition. Similarly there is much variation in the distance between the endings of R_{4+5} and m.

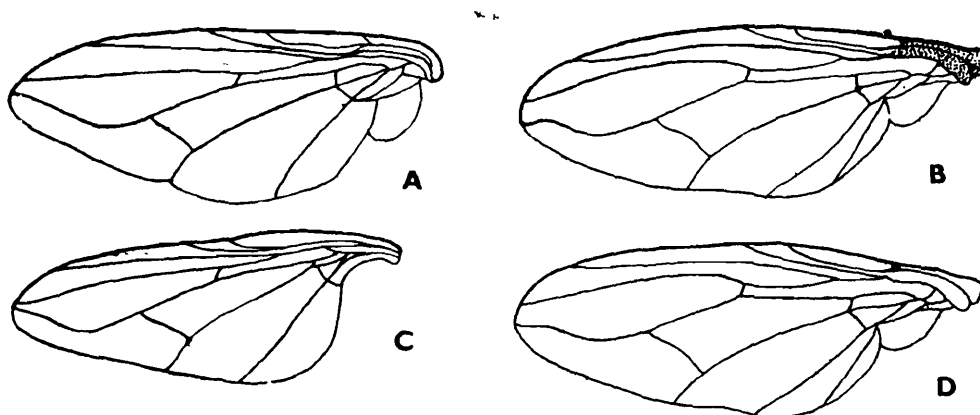


Fig. 4 A-D. *Orthellia coerulea* (Wiedemann), venation : A, B, variation of shape of m-m cross-vein ; C, D. variation in the distance between the endings of R_{4+5} and m.

Yet another variation exhibited by this fly is in the posterolateral fringe of hairs, whose number and length vary from specimen to specimen.

REMARKS

Such variations could confuse a taxonomist if he approaches them with a narrow concept of species, forgetting the complexities of nature. Unless he broadens his horizon he will never succeed in his task. According to Gillet (1971), all these variations are stages in the evolutionary process. Whether these variations will lead into speciation will depend on how exacting are the conditions favouring them or how long one population remains isolated from the other. The farthest they are from the common plan the nearest they are to new species.

ACKNOWLEDGEMENTS

We are grateful to the Director, Zoological Survey of India, Calcutta, for the facilities of work and for encouragement.

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DIVERSITY INDICES IN RELATION TO INTRA POPULATION VARIATION IN TWO SPECIES OF MYCOPHAGOUS TUBULIFERAN THYSANOPTERA

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The species being dynamic from the view point of time is bound to show extensive variation, though the species as a whole may retain its characteristics. An assesment of the magnitude of these variations resulting from studies of sizable populations is essential for a proper recognition of the patterns of variation so as to enable a better understanding of the limits of diversity of the concerned species. Many species of thrips, particularly the mycophagous ones, offer enormous scope for studies of intraspecific diversity or phenotypic flexibility, the gap between the extreme morphs in a population being unbelievably large. Quite some differences of opinion exist regarding the correct terminology to be used for such variations, as for e.g., sex-limited polymorphism, polyphenism or simply morphism. In view of the coexistence of different morphs in the same population, the definition of polymorphism as adopted by Richards (1960) appears useful, namely "one or more of sexes of the species occurring in two or more forms which are normally sharply distinct to be recognisable without morphometric analysis" The basis of morpholo-

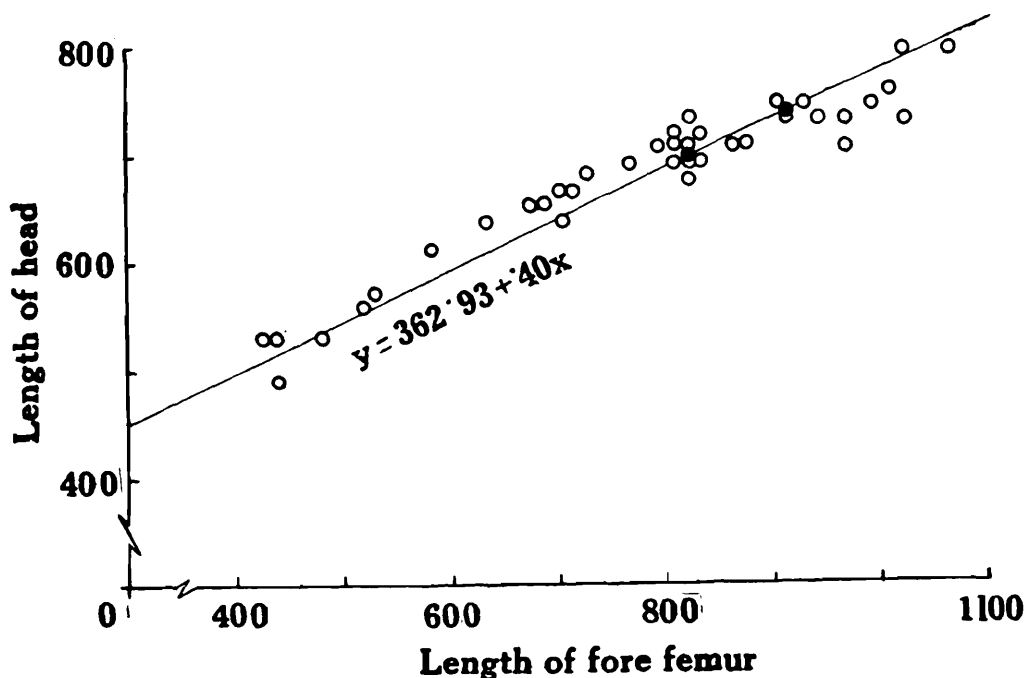


Fig. 1. *Mecynothrips gigans* : Regression line and scatter diagram showing the relation between length of head and length of fore femora.

gical analysis, though an essential aspect of species dynamics, is not an *end-all* criterion for species determination, because several instances exist where the females of two or more species occupying the same habitat may be extremely similar morphologically, even to the extent of identical colouration, but differing in some other striking characters in the males. Again when alary polymorphism coexists in species showing sex limited diversity, further complications appear to arise in the variable form of the head, phenomenal increase in the size of the prothorax and incidental increase in size of the fore legs. A detailed discussion regarding the effects of the extreme morphs *viz* oedymmerism and gynaeoidism, as well as the impact of alary polymorphism among the individuals of a population have been provided by Ananthakrishnan (1961, 65, 67-71, 73), Hood (1935, 1937), Mound ('71, 72).

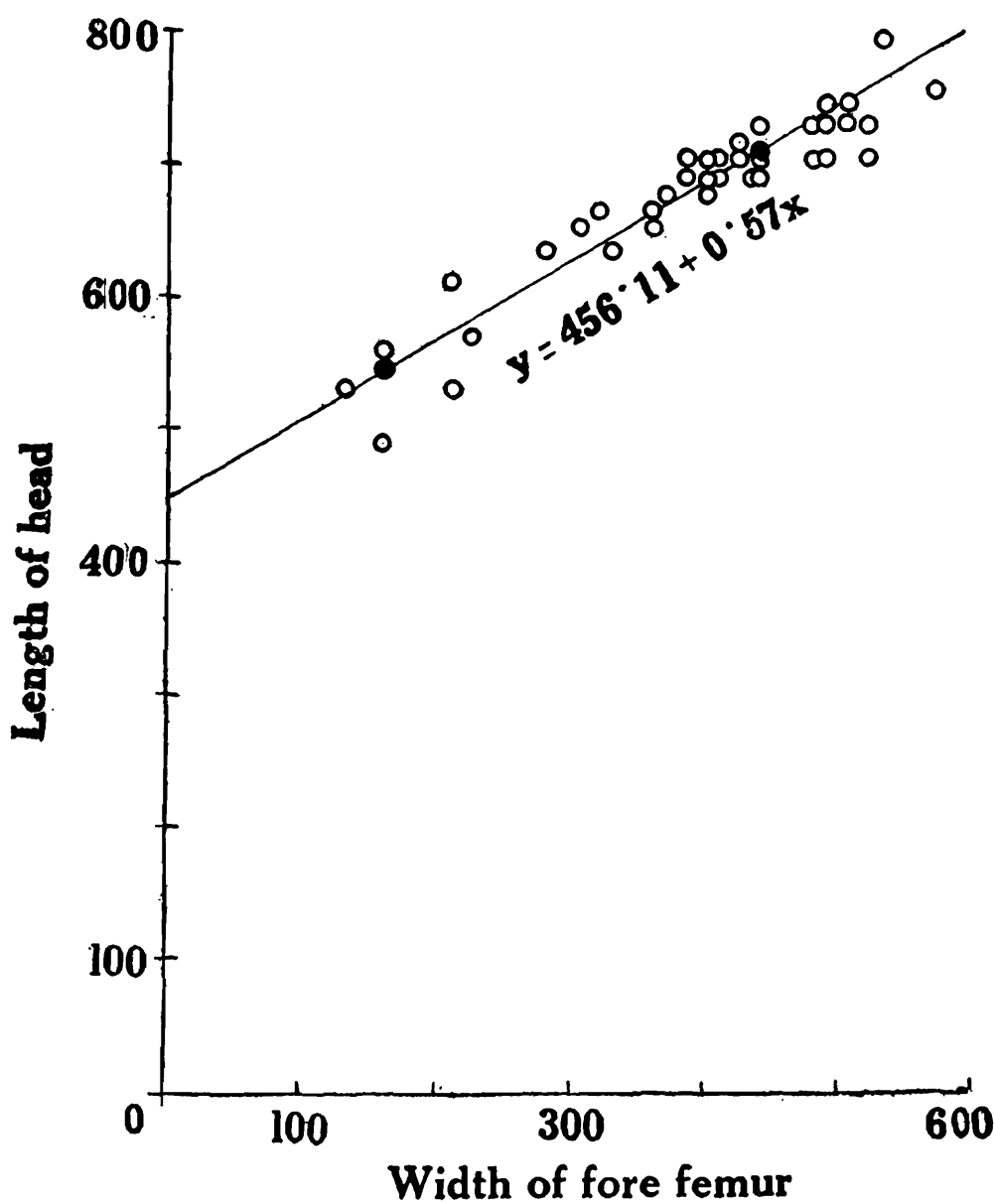


Fig. 2. *Mecynothrips gigans* : The relation between length of head and width of fore femora.

Variations as we understand them in the normal sense, may become magnified to a very large extent by a high incidence of allometry/allomorphy or relative growth as evident in a study of a large series in a population. Growth rates form a part of general organisation of the body, and changes in growth rate of one part of the body is invariably associated with similar changes in the neighbouring part. For this purpose, the number of individuals in a population is a very important measure of diversity and when the form and abundance are known, it enables a statistical interpretation of the growth rates of various parts of the body in the different morphs. In view of the existence of at least 3 distinct morphs namely gynacoid, normal, oedymorous individuals among the males in a population of the two species discussed below, it becomes easy to compute the diversity indices and calculate the correlation

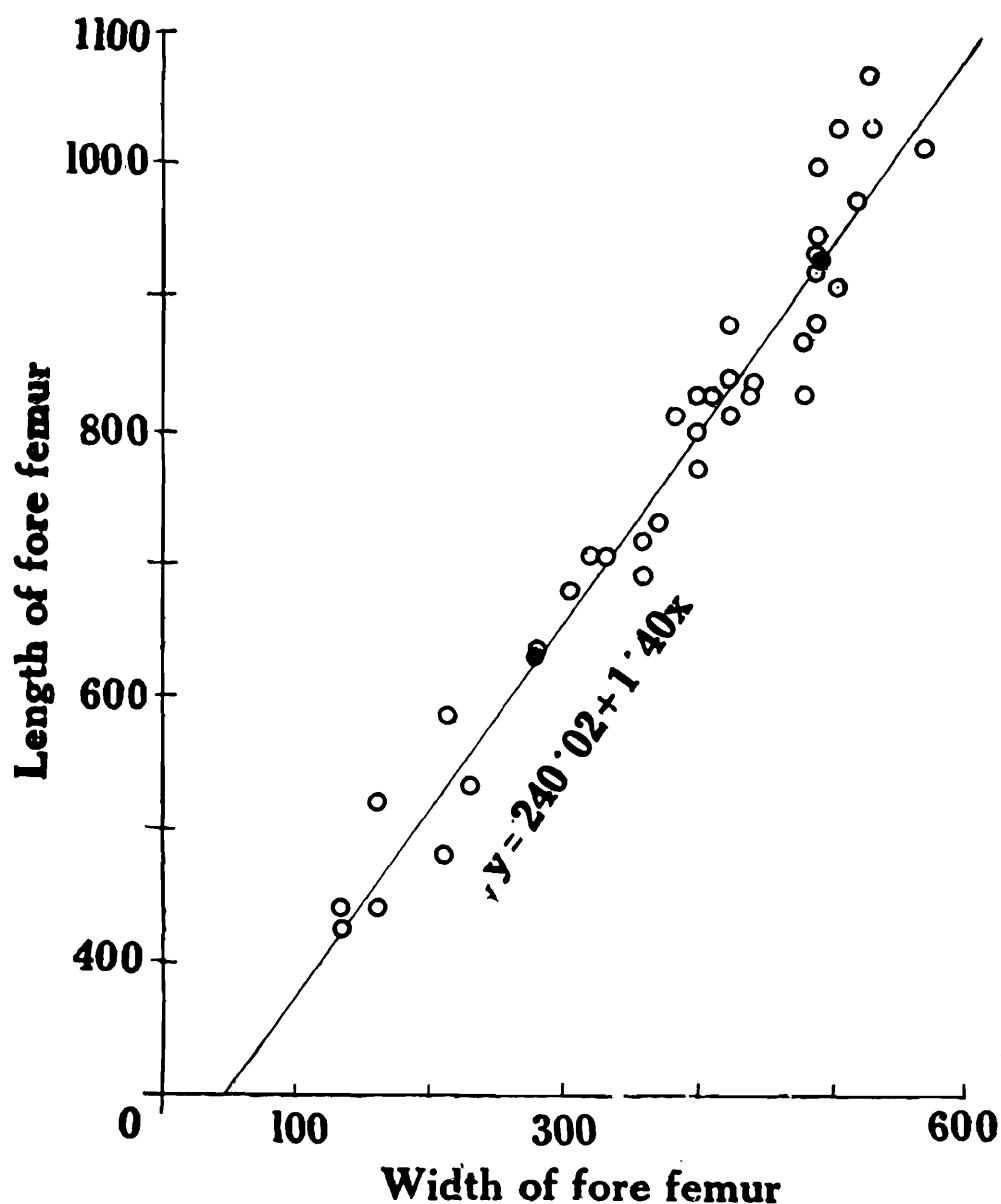


Fig. 3. *Mecynothrips gigans* : The relation between length of fore femur to that of its width.

coefficients between the various parts, so as to arrive at the significance of these relationships.

Sizable population of two mycophagous Tubulifera namely *Mecynothrips simplex* (Schmutz) and *Tiarothrips subramanii* (Ramk.) were analysed in this study, to enable a proper understanding of the relative growth rates of such parts of the body as the length and width of fore femora in relation to the

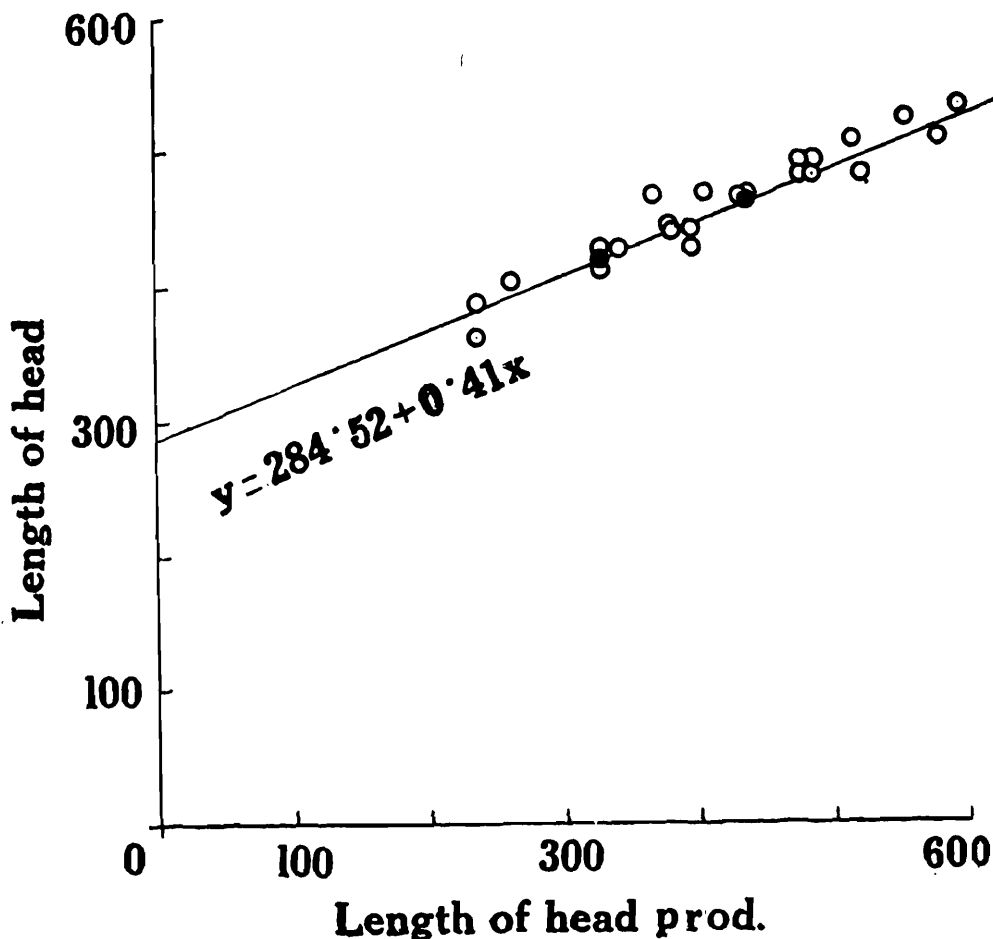


Fig. 4. *Tiarothrips subramanii*: Relation between length of head and length of head production.

length of head in *Mecynothrips gigans* (the head process and the third antennal segment not showing significant variation); and the lengths of the head production, third antennal segment and fore femora in relation to the head length in *Tiarothrips subramanii* (the head process, third antennal segment and forefemora keeping pace with the head and showing significant variation). It is well known that calculation of the growth coefficient is an expression of the relative growth rate of the concerned part in relation to some other parts. In both the species discussed, it is a case of positive allometry. A preliminary analysis of a large series of individuals in a population, also indicates the limits diversity of the concerned morphs, as for e. g. in *Mecynothrips gigans*, extreme

gynaecoid males have the head length greater than fore femoral length ; in normal individuals the head length is almost equal to the length of the fore femora ; in extreme oedymeres the fore femoral length is very much greater than the head. In *Tiarothrips subramanii* in the extreme gynaecoids, the head length is greater than the lengths of the head production, third antennal

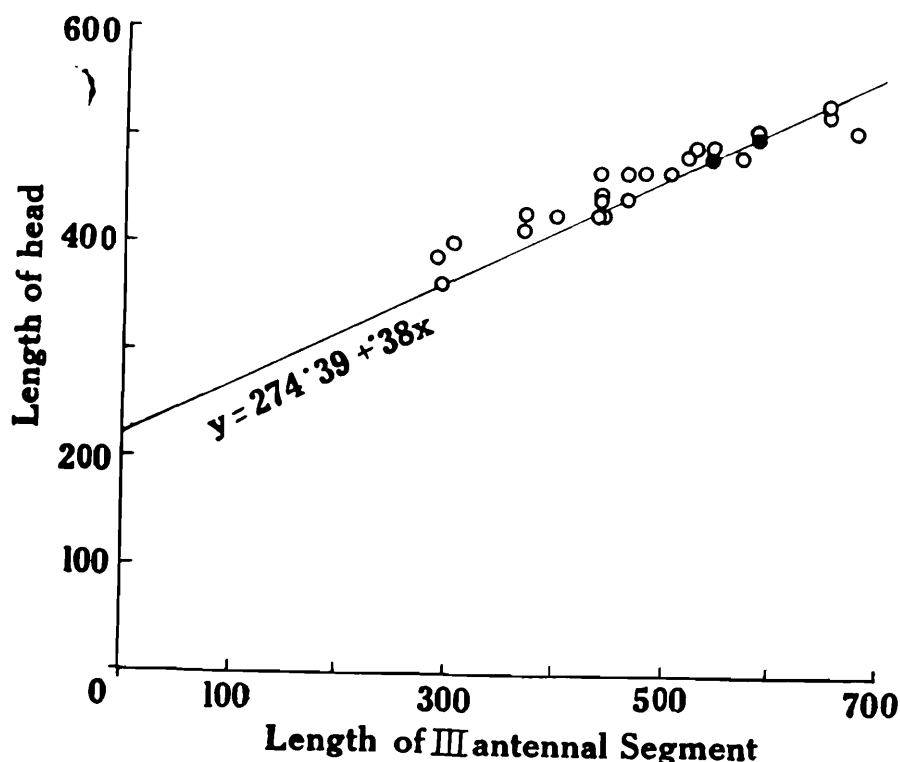


Fig. 5. *Tiarothrips subramanii* : Regression line and the scatter diagram, showing the relation between length of head and length of iii antennal segment.

segment and forefemora ; the normal individuals have head production shorter than the head length, but the third antennal segment and forefemora are longer, in the maximum oedymeres the head is shorter than the length of the head production, third antennal segment and forefemora.

Results of statistical analysis indicating the relationship between growth rate of head length (y) in relation to the head production, third antennal segment and forefemoral length in *Tiarothrips* and lengths and width of the forefemora in *Mecynothrips* are presented in Tables 1 & 2. A highly significant positive correlation was evident, significant at 1% level. Regression lines were obtained by pooling together data from the population of individuals using the formula $Y = a + bx$ and the combined regression lines drawn along with the respective scatter diagrams are indicated in Figs. 1-6.

TABLE 1. *Mecynothrips gigans*.

	Mean	Correlation coefficient between lengths of head and forefemora and fore- femoral width.	Regression line of head length (Y) on two factors (X) $Y = a + bx$
1. Y : Length of head	682.12		
2. Length of fore femur	789.09	0.9575**	$Y = 362.93 + .40x$
3. Width of fore femur	393.60	0.9495**	$Y = 456.11 + 0.57x$
	Mean	'Y' Value between Length of forefemora & the forefemoral width	Regression line of length of forefemur (Y) on width of forefemur $Y = a + bx$
Y : Length of fore femur	789.09		
Width of fore femur	393.60	0.9745**	$Y = 240.02 + 1.40x$

** Significant at 1% level

TABLE 2. *Tiarothrips subramanii*

	Mean	Correlation coefficient between Head length & other three lengths	Regression line of Head length (Y) three other lengths (X) $Y = a + bx$
1. Y : Head length	456.46		
2. H. P. Length	422.88	0.9677**	$Y = 284.52 + 0.41x$
3. 3rd Antennal length	479.00	0.9533**	$Y = 274.39 + 38x$
4. Fore femoral length	467.77	0.9591**	$Y = 185.67 + 0.58x$
2. Y : H. P. Length	422.88		
3. 3rd Antennal length	479.00	0.9850**	$Y = 24.94 + 0.93x$
4. Fore femoral length	467.77	0.9833*	$Y = 237.89 + 0.41x$

Mound (1971) reviewing the genus *Mecynothrips* Bagnall, indicates the existence of a similar linear relationship between head length and the length of the third antennal segment. He further mentions that in larger individuals the antennal segments as well as head production must be relatively

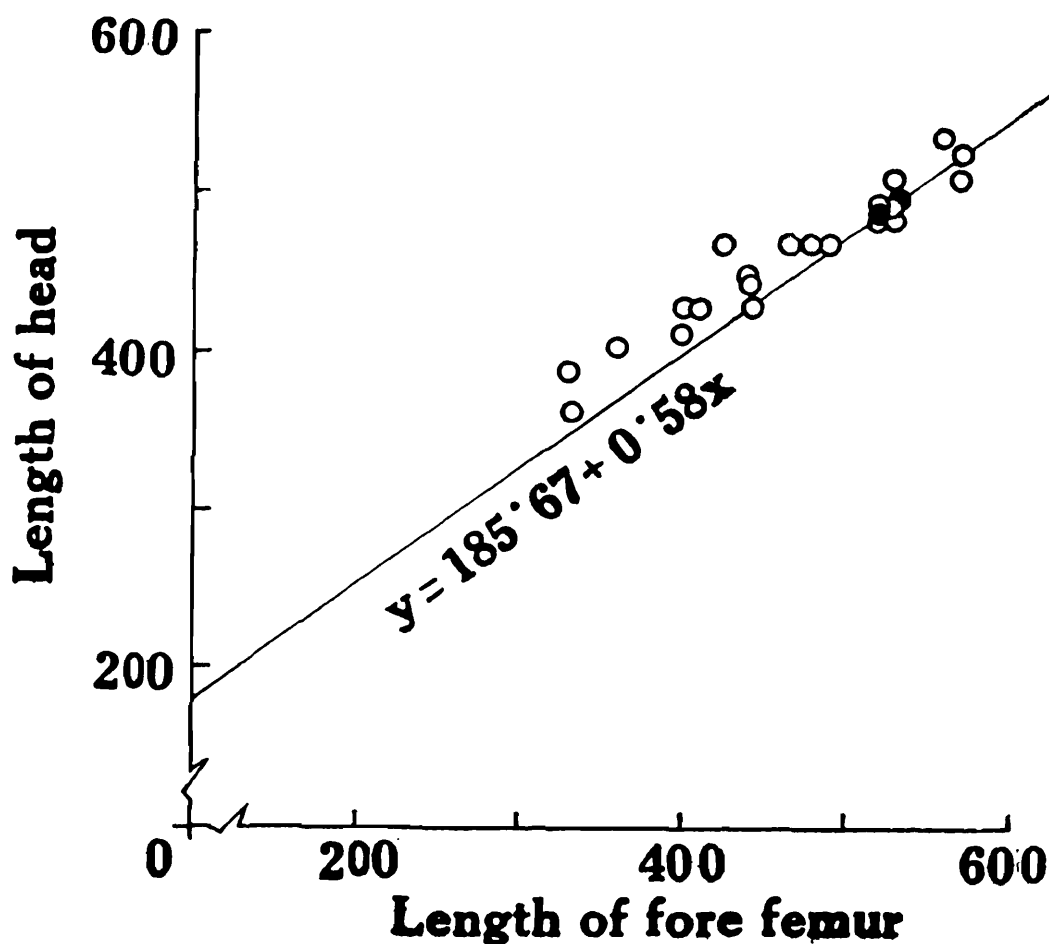


Fig. 6. *Tiarothrips sabrananii*: Relation between head length and length of fore femur.

more slender, since any increase of the apical width at the same rate as the length of the antennae would result in unwieldy antennae. The size of the pronotal horns in males is similarly another variable feature in males of *Mecynothrips*.

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ASPECTS OF INTRASPECIFIC VARIATION IN *CHLAENIUS*
BIMACULATUS DEJEAN (CARABIDAE : CHLAENIINI :
COLEOPTERA)

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INTRODUCTION

Chlaenius Bonelli is the largest genus of the tribe Chlaeniini, with a worldwide distribution. In so far as is known, it includes 125 species, more species than any other genera of the family Carabidae known from the Indian region. *Chlaenius* is taxonomically complex with its representatives predominantly bright coloured, foul-smelling, pubescent and inhabit under stones, logs, leaf litters, vegetable debris, on ground, usually near humid places and are often attracted at light.

The only monograph of the world species of the genus *Chlaenius* is that of Chaudoir's (1876). In last hundred years since the publication of this pioneer work, many species have been described chiefly by Bates (1876-1892) and Andrewes (1819-1826). Many of these species are synonyms and some common species have been often confused both in collection and published faunal works. During the revisionary work of the Indian species of the genus *Chlaenius* it was observed that some species possess considerable external morphological diversity, but the genital organs, particularly the aedeagus, are identical. Some closely related species can hardly be differentiated having very minor external morphological difference but their aedeagus are different. In *Chlaenius* the genitalia, particularly the aedeagus provide the most consistent character for species recognition. Aedeagal characteristics are exceptionally homogenous at infraspecific level, but otherwise quite variable. Characteristics of female genitalia, particularly valvulae are specially distinct within same species group or subgenus.

The species *Chlaenius bimaculatus* was first established by Dejean (1826) from Java based on the characters viz. yellowish femur and reddish tibiae and tarsi. He placed this species in his 'Premiere Division' near his species *C. maeulatus* and *C. binotatus*. Laferte (1851) placed this species in his table along with *neelgheriensis* (Guer.), *biguttatus* Dejean, *binctus* Dejean and *vulneratus* Dejean. Chaudoir (1876) placed the species under Laferte's group *Ocybatus* near the species *bioculatus* Chaudoir. He also considered the species *C. flaviguttatus* Macleay as same with *bimaculatus*, which has subsequently been established as a distinct species. Chaudoir (1856) described the species *C. lynx*

from Hongkong and separated it from *bimaculatus* by its entirely yellowish brown legs. Later, Andrewes (1930) included it under *bimaculatus* as a variety. Schaufuss (1887) raised a variety *celebensis* of *bimaculatus* from Celebes Islands having blackish legs. Bates (1891) described a closely related species *C. rayotus* from Chotanagpur based on wholly reddish brown legs and coarsely, densely punctate pronotum. Andrewes (1923) described another closely related species *C. ocellatus* based on the specimens from Jabalpur, Madhya Pradesh having relatively coarsely and densely punctate pronotum, yellowish femur and slightly darker tibiae and tarsi.

Having intraspecific external morphological differences the species *C. bimaculatus* Dejean has repeatedly been confused both in collections and published works. So a redescription of the species with detailed observation on distributional variation is given below.

***Chlaenius bimaculatus* Dejean**

Chlaenius bimaculatus Dejean, *Spec. gen. Col.*, II, 1826 : 301. var. *lynx* Chandoir, *Bull. Soc. Imp. Nat. Mosc.* xxix, 1856, III : 199. var. *celebensis* Schaufuss, *Horae Soc. ent. Ross.*, XXI, 1887 : 105.

Chlaenius rayotus Bates, *Ann. Soc. ent. Belg.*, XXXV, 1891 : 327. New Synonymy

Chlaenius ocellatus Andrewes, *Ann. Mag. nat. Hist.*, (9) XI, 1923 : 339. New Synonymy.

Measurements : Total length 12.7 mm. -14.0 mm. width 4.7 mm. -5.5 mm.

General appearance (Fig. 1A) elongate-oval; head and pronotum dark metallic bronze-green or blue-green with reddish reflection, elytra subopaque, obscure black with two large yellowish brown spots near apical third; mandibles dark reddish brown; labrum yellowish brown; palpi wholly reddish brown or apex of apical segments narrowly bordered with pale yellow or brown with apex of apical segments broadly bordered with pale yellow, or blackish brown with apex of apical segments broadly and basal half of subapical segments pale; antennae dark brown with segments 1-3 pale, or blackish brown with segment 1 pale; legs wholly reddish brown or almost black, or femur yellowish brown and apex of femur, tibiae, tarsi and trochanters brown or dark brown; ventral side shining dark reddish brown.

Head convex, slightly wider than long, width/length of head = 1.06–1.10; dorsal surface finely and densely punctate, finely and longitudinally rugose on lateral sides, sparsely punctate, obscurely and transversely rugose on centre; isolated patches of retinacular microsculpture moderately visible; tentorial pits large and prominent, frontal grooves short and shallow to moderately deep; clypeus minutely and somewhat densely punctate; labrum more than twice as wide as long, truncate or gently emerginate at apex, setigerous punctures arranged along apical margin at almost equal intervals; palpi slender and elongate; antennae slender, reaching nearly apical third of elytra; eyes

moderately large and projecting, width of eyes/width of head across eyes = .39 – .40 ; temporae slightly contracted behind the eyes.

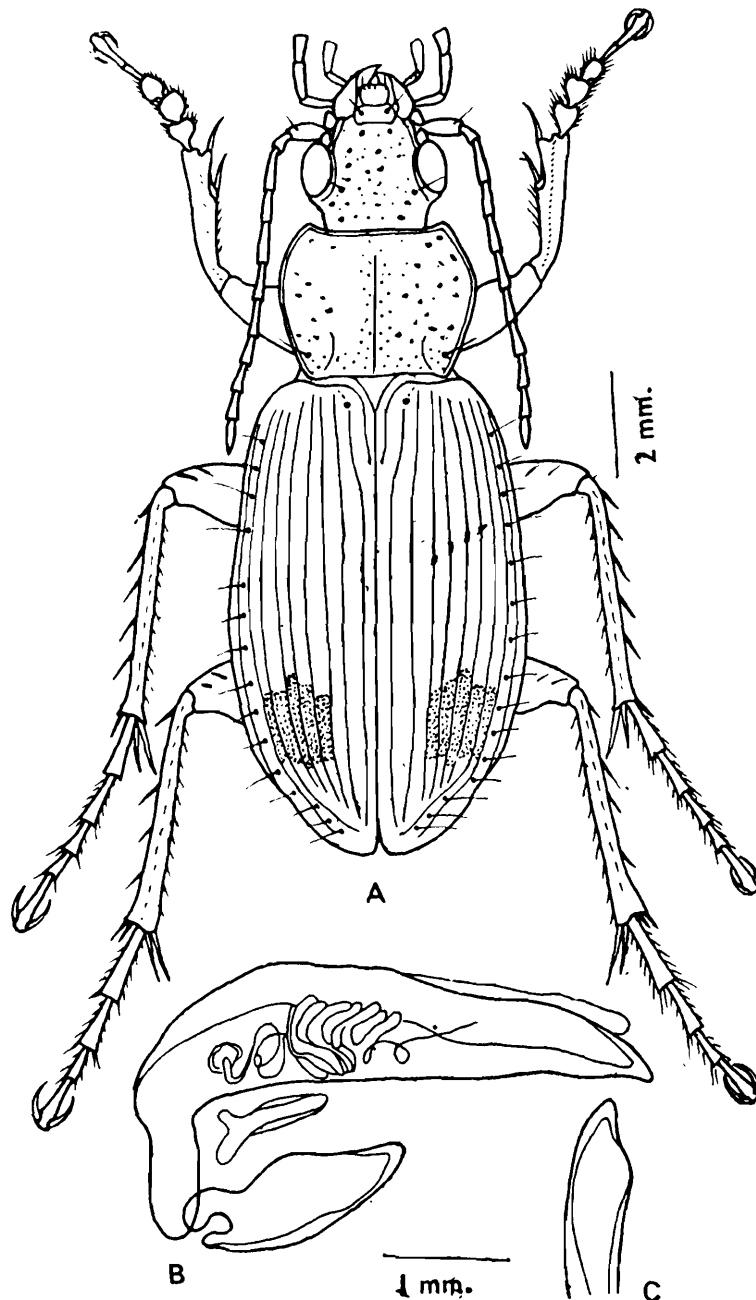


Fig. 1. *Chlaenius bimaculatus* Dejean, A-Entire dorsal view, B-left aspect of aedeagus, C-dorsal aspect of apical lobe.

Pronotum convex, oval, transverse and widest slightly before middle, greatest width of pronotum/width of head across eyes = 1.44 – 1.48, greatest width of pronotum/length of pronotum = 1.20 – 1.25, basal width of pronotum/greatest width of pronotum = .67 – .69 ; apex slightly narrower than base, apical margin entirely and narrowly bordered, slightly emerginate, anterior angles slightly projecting, obtuse and moderately rounded ; lateral sides gently and almost evenly curved, lateral margins finely bordered, faintly translucent

and narrowly reflexed, reflexed margins prominent towards posterior angles ; base slightly contracted, basal margin truncate, posterior angles obtuse and broadly rounded ; surface coarsely and somewhat densely punctate near base and on either side of median line, coarsely and densely to finely and sparsely punctate on disc ; granuloretinacular microsculpture moderately distinct ; median line fine, obscurely reaching the base, transverse impressions obsolete ; basal grooves deep and curved towards posterior angles ; basal grooves contiguous with the concavity formed by the reflexed part of the lateral margins.

Elytra convex, oval, widest slightly after middle, width of elytra/greatest width of pronotum = 1.43–1.46, length of elytra/greatest width of elytra = 1.55–1.60 ; lateral sides gently curved from below shoulder to widest point, moderately curved at shoulder, distinctly sinuate near apex in ♂ and faintly so in ♀ ; basal margin moderately curved, humeral angles slightly rounded ; striae distinct, rather distinctly and closely punctate ; interstices convex, rather coarsely and densely punctate with conspicuous yellowish pubescence ; microsculpture isodiametric and distinct ; apical spots almost quadrate extending outward from striae 3 to 8, colour extends forward on the interstices 4, 5 and 6 and backwards on 6, 7 and 8. Epipleurae almost flat, finely, sparsely punctate and pubescent.

Ventral side almost glabrous and impunctate ; prosternal process with raised margin, tip glabrous, prosternum finely and sparsely punctate, proepisterna faintly and sparsely punctate near inner margins ; mesepisterna coarsely punctate along inner margins ; metasternum coarsely and moderately densely punctate, metepisterna nearly twice as long as wide, outer margin sulcate, coarsely and sparsely punctate ; abdominal sternites somewhat coarsely and densely punctate and longitudinally rugose at sides, finely and sparsely punctate at middle with minute pubescence.

Legs slender and elongate, spinose setae of tibiae sparse, long and slender ; male anterior femora with a spine on ventral sides near the base and first three segments of anterior tarsi with dorsal surface sparsely and minutely punctate, first segment triangular nearly as long as wide and its apical margin oblique and notched at middle, second segment distinctly transverse, third almost rounded and as long as wide.

Aedeagus (Figs. 1B & C) abruptly bent at a distance from base, then almost straight ; apical lobe slightly differentiated, short and triangular, apex narrowly rounded ; internal filament highly coiled, basal plate prominent ; left paramere obtusely pointed at apex.

Material examined INDIA : ARUNACHAL PRADESH, Kameng Division, Moshing vill. , 2308 m. , 1 ex. , 26. iii. 1961, K. C. Jayaram ; Shergao vill. , 2038 m. , 1 ex. 29. iii. 1961, K. C. Jayaram ; Rohung vill. , 1846 m. , 1 ex. , 8. iv. 1961 K. C. Jayaram ; Chung vill. , 2154 m. , 1 ex. , 14. iv. 1961, K. C. Jayram ; Milankang R. Bank, 2154 m. , 4 exs. , 20. iv. 1961, K.

C. Jayaram ; Bomdila, 2646 m. , 1 ex. , i. v. 1961, *K. C. Jayaram* ; Subansiri Division, Dafla Hills, Dunsiri Valley, 925 m., 2 exs.,—*II. H. G. A.* ; Ziro., 1585 m. , 1 ex. , 14. v. 1966, *A. N. T. Joseph* ; Diphabun, Lohit, 1280 m. , 1 ex. , 12. xii. 1969, *J. M. Julka* ; Siang Division, above Panji, 1231 m. , 2 ex. , 16. i. 1912, *S. Kemp* (Abor Expedition) ; Puding, 925 m. , 1 ex. , ii. 1912, *S. Kemp* ; ASSAM, —1 ex. ; MEGHALYA, Shillong, 3 exs., —; Khasi Hills, 2 exs. , 15-17. v. 1964, *S. Biswas* ; W. BENGAL, Darjeeling Dist. , Eagles Crag (nr. Kurseong Stn.) 1 ex. , *M. Sharif* ; Pashok, 1538 m. , 1 ex. , Mungphu, 2 ex. v. 1914, *F. H. Gravely* ; Kalimpong, 615 -1384 m. , 1 ex. , Sulherland ; Murshidabad dist. Berhampore, 2 ex. , (at light) ; ORISSA, Angul, 2 ex. 30. ix. 1972, *K. Rai & Party* ; BIHAR, Mungher, 1 ex. , 22. 9. 1909, *J. T. Jenkins* ; Chotanagpur, Pass between Chaibasa and Chakradharpur, 1 ex. , 2-4. iii. 1913, *F. H. Gravely* ; UTTAR PRADESH, Lucknow 1 ex. , 4. ii. 1908, *R. H.* ; Hardwar, 1 ex. , -*J. W. M.* ; Barcot Forest, Dehra Dun dist. , 1 ex. , 8. viii. 1965, *R. K. Bhatnagar* ; MADHYA PRADESH, Jabalpur, Balaghat Tank, 8. viii. 1967, *H. P. Agarwal* ; Moianala, 1 ex. 23. vii. 1934, *S. N. Chatterjee* ; MAHARASHTRA, Bannoli (Satara dist.) to Akapa (Ratnagiri dist.) 2 exs., 27. x. 1912. *Agharkar* ; ANDHRA PRADESH, Vizagapatnam, 1 ex. ; TAMILNADU, Coimbatore, 1 ex. , 16-24. ix. 1914, *F. H. Gravely* ; KERALA, Trivandrum, 1 ex.

OTHER COUNTRIES : NEPAL : Thosé, 1 ex. , 19. xi. 1952, *British Nepal Expedition* (B. M. N. H.) ; BHUTAN : West Bhutan, Punakha Valley, 1372 m. , 4 exs. , 28. ii. 1969, *B. Biswas* ; West Bhutan, Susura, 1 ex. , 12. ii. 1969, *B. Biswas* ; BURMA : Mish ne Hills, Delei R. , 523.m. , 3 ex. , 28. i. 1935, *M. Steele* (B. M. N. H.) ; Upper Burma, Nam Tamal Valley, 1 ex. , 14. viii. 1938, *R. Kaulback* (B. M. N. H.), Upper Burma, Mvirkvina dist. , Kamaing, 1 ex. , 29. x. 1926, *B. N. Chopra* ; CHINA : West China, Yunnan, 1 ex. , 1909-1910, *J. C. Brown*.

DISTRIBUTION

This species is distributed almost throughout India and also widely distributed in South East Asia including China.

INDIA : ARUNACHAL PRADESH, MANIPUR, ASSAM, MEGHALAYA, SIKKIM, WEST BENGAL, BIHAR, ORISSA, ANDHRA PRADESH, MADHYA PRADESH, MAHARASHTRA, TAMILNADU and KERALA.

OTHER COUNTRIES : NEPAL, BHUTAN, BURMA, SRI LANKA, CHINA, LAOS and MALAYA ARCHIPELAGO.

Remarks : This species is closely related to *Chlaenius flaviguttatus* Macleay, but it can be easily separated from latter species by its oval and relatively short pronotum, the lateral sides being moderately rounded.

The authors consider *rayotus* Bates and *ocellatus* Andrewes as conspecific with *bimaculatus* Dejean as their external morphological differences (as discussed under 'variation'), falls within the variational limits of *bimaculatus*

TABLE 1. Distributional variation of morphological characters in different populations of *Chlaenius bimaculatus* Dejean

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Characters (Figs.)	Pronotum (Fig. 2A-2D)				Legs (Figs. 2E-2I)					Palpi (Figs. 3A-3E)					Antennae (Figs. 3F-3J)				
Populations	2A	2B	2C	2D	2E	2F	2G	2H	2I	3A	3B	3C	3D	3E	3F	3G	3H	3I	3J
1. KERALA : Trivandrum	o				o					o					o				
2. TAMILNADU : Coimbatore	o				o						o				o				
3. MAHARASHTRA ; Bamnoli to Akapa	o				o					o					o				
4. UTTAR PRADESH : Lucknow	o				o					o					o				
5. BIHAR : Chotanagpur, Mungher	o				o					o					o				
6. ORISSA : Angul	o				o					o					o				
7. ANDHRA PRADESH : Vizagapatnam	o					o					o				o				
8. MADHYA PRADESH : Jabalpur		o				o						o				o			
9. UTTAR PRADESH : Dehra Dun, Hardwar		o				o						o				o			

TABLE 1. (Contd.)

Characters (Figs.)	Pronotum (Fig. 2A-2D)				Legs (Figs. 2E-2I)					Palpi (Figs. 3A-3E)					Antennae (Figs. 3F-3J)				
Populations	2A	2B	2C	2D	2E	2F	2G	2H	2I	3A	3B	3C	3D	3E	3F	3G	3H	3I	3J
10. WEST BENGAL : Berhampur			o				o					o						o	
11. MEGHALAYA : Shillong, Khasi Hills			o				o					o						o	
12. ASSAM : ?			o				o					o						o	
13. ARUNACHAL PRADESH : Subansiri & Siang Divs.			o				o					o						o	
14. BURMA : Upper Burma, Mishmi Hills			o				o					o						o	
15. CHINA : Yunan			o				o					o						o	
16. WEST BENGAL : Darjeeling dist.			o					o					o					o	
17. NEPAL : Those			o					o					o					o	
18. ARUNACHAL PRADESH : Kameng Div.				o					o					o					o
19. BHUTAN : West Bhutan				o					o					o					o

and these differences may be interpreted as due geographical variation. These possess aedeagus most identical with that of *bimaculatus* which provides the most consistent character for species recognition.

VARIATION

While studying a series of specimens of *Chlaenius bimaculatus* Dejean from different parts of India and some of its neighbouring countries an interesting variation with respect to distribution was observed. This morphological diversity in relation to distribution appears to be of interest, particularly in the punctuation of pronotum and in the colour of legs, palpi and antennae. Populations from 19 different areas have been studied and morphological diversity described in detail followed by a table (Table 1) showing distributional variation.

a) Variation in punctuation

Pronotum (Figs. 2A-D).—Punctuation on pronotum particularly on its disc varies to a great extent from coarse and dense to fine and sparse. Punctures are coarse and dense (Fig. 2A) in examples from Kerala, Tamilnadu, Maha-

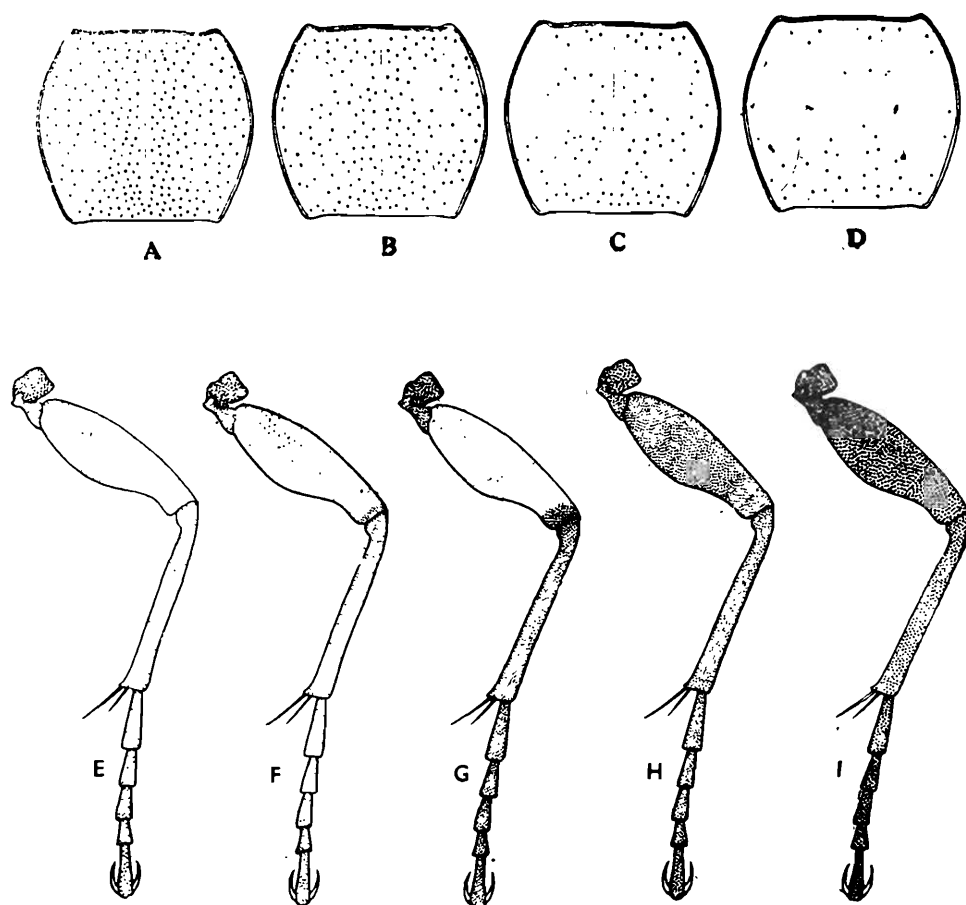


Fig. 2. A-D. Pronotum of *Chlaenius bimaculatus* Dejean, showing variation in punctuation; E-I Legs. E entirely reddish brown, F femur yellowish brown, apex of femur, tibia and tarsi brown, G femur yellowish brown, apex of femur tibia and tarsi dark brown, H entirely dark brown, I -entirely black,

rastra, Andhra Pradesh, Orissa, Uttar Pradesh (Lucknow) and Bihar, relatively sparse (Fig. 2B) in those from Madhya Pradesh and Uttar Pradesh (Dehra Dun and Hardwar), moderately fine and sparse (Fig. 2C) in those from W. Bengal, Meghalaya, Assam, Arunachal Pradesh (Subansiri and Siang Divisions—below 1800 m.), NEPAL, BURMA and CHINA and very fine and sparse (Fig. 2D) in Arunachal Pradesh (Kameng Division—above 1800 m.) and BHUTAN.

b) *Variation in colour*

Legs (Figs. 2E-1).—Colour of the legs vary to a considerable degree from uniformly reddish brown to black as shown in the figures. Femora are reddish brown (Fig. 2E) in forms collected from Kerala, Tamilnadu, Maharashtra, Orissa (slightly paler), Uttar Pradesh (Lucknow) and Bihar, whereas yellowish brown with a narrow brown patch at apex (Fig. 2F) in those from Andhra Pradesh, Madhya Pradesh and Uttar Pradesh (Dehra Dun and Hardwar), yellowish brown with a broad patch of dark brown at apex (Fig. 2G) in those from W. Bengal (Berhampur), Meghalaya, Assam, Arunachal Pradesh (Subansiri and Siang Divisions—below 1800 m.), BURMA and CHINA, uniformly dark brown (Fig. 2H) in those from W. Bengal (Darjeeling dist.) and NEPAL and uniformly black (Fig. 2I) in Arunachal Pradesh (Kameng Div.—above 1800 m.) and BHUTAN. Likewise reddish brown colour of femora, colour of tibiae and tarsi are also reddish brown (Fig. 2E) in specimens from Kerala, Tamilnadu, Maharashtra, Orissa (slightly paler), Uttar Pradesh (Lucknow) and Bihar, whereas brownish, slightly darker than femora (Fig. 2F) in those from Andhra Pradesh, Madhya Pradesh and Uttar Pradesh (Dehra Dun and Hardwar), unlike yellowish brown colour of the femora colour of tibiae and tarsi are dark brown (Fig. 2G) in those from W. Bengal (Berhampur), Meghalaya, Assam, Arunachal Pradesh (Subansiri and Siang Divisions—below 1800 m.), BURMA and CHINA. Likewise the colour of femora, colour of tibiae and tarsi are dark brown (Fig. 2H) in those from West Bengal (Darjeeling dist.) and NEPAL and black (Fig. 2I) in those from Arunachal Pradesh (Kameng Div.—above 1800 m.) and BHUTAN. Trochanters are always similar in colour to tibiae and tarsi.

Palpi (Fig. 3A-E).—Both maxillary and labial palpi vary in colour to a considerable extent. These are uniformly reddish brown (Fig. 3A) in specimens from Kerala, Maharashtra, Orissa, Uttar Pradesh (Lucknow) and Bihar, whereas reddish brown with apex of apical segments narrowly bordered with pale yellow (Fig. 3B) in those from Tamilnadu and Andhra Pradesh, brown or dark brown with apex of apical segments broadly bordered with pale yellow (Fig. 3C) in those from Madhya Pradesh western Uttar Pradesh (Dehra Dun and Hardwar), W. Bengal (Behrampur), Meghalaya, Assam, Arunachal Pradesh (Subansiri and Siang Divisions—below 1800m.), BURMA

and CHINA, uniformly darkbrown (Fig. 3D) in W. Bengal (Berhampur) and NEPAL, and black with apex of apical segments broadly and basal half of subapical segments pale (Fig. 3E) in Arunachal Pradesh (Kameng Division above 1800 m.) and BHUTAN.

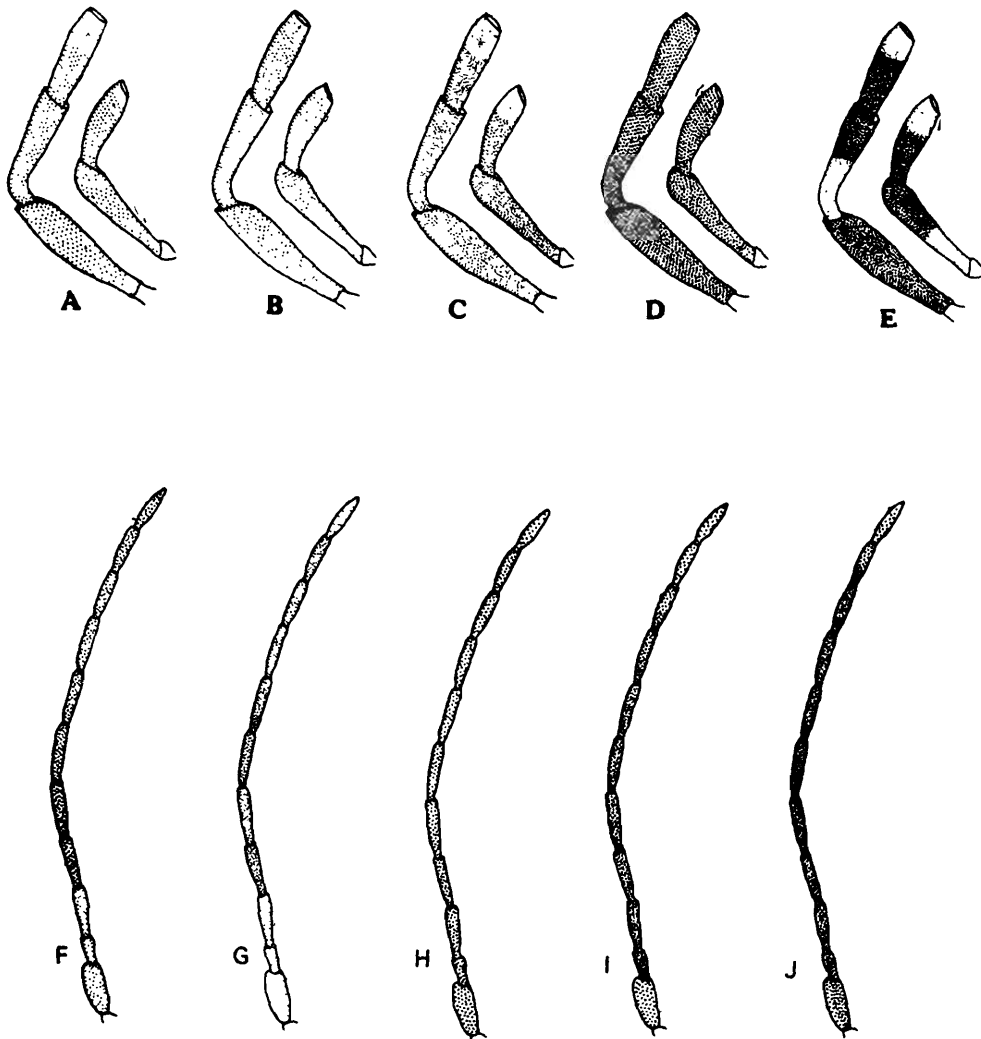


Fig. 3. *Chlaenius bimaculatus* Dejean ; A-E. Palpi. A entirely reddish brown, B- reddish brown with of apical segments narrowly pale, C brown of dark brown with apices of apical segments broadly pale, D entirely dark brown, E black with apices of apical segments broadly and basal half of subapical segments pale; F-J. Antennae. F segmets 1-3 reddish brown, 4-11 brown or dark brown, G - segment 1 yellowish brown, 2+3 reddish, 4-11 brown or dark brown, H - segment 1 brown, 2-11 dark brown, I - segment 1 yellowish brown, J segment 1 brown. 2-11 black.

Antennae (Figs. 3F-J). —Colour of antennae particularly of segments 1-3 varies considerably. If the segments 1, 2+3 and 4-11 are considered separately, segment 1 is reddish brown (Fig. 3F) in the specimens from Kerala, Tamilnadu, Maharastra, Andhra Pradesh, Orissa, Uttar Pradesh (Lucknow) and Bihar, whereas yellowish brown (Fig. 3G&I) in those from Madhya Pradesh, Uttar Pradesh, (Dehra Dun and Hardwar), W. Bengal (Berhampur), Meghalaya, Assam, Arunachal Pradesh (Subansiri and Siang Divisions - below 1800

m.), BURMA and CHINA, brownish (Fig. 3H & J) in West Bengal (Darjeeling dist.) Arunachal Pradesh (Kameng Division—above 1800 m.) BHUTAN and NEPAL. IN case of segments 2+3 colour is reddish brown (Figs. 3F & G) in those from Kerala, Tamilnadu, Maharashtra, Andhra Pradesh, Orissa, Uttar Pradesh, Bihar and Madhya Pradesh, whereas dark brown (Figs. 3H & I) in those from W. Bengal, Meghalaya, Assam, Arunachal Pradesh (Subansiri & Siang Divisions below 1800 m.), NEPAL, BURMA and CHINA, and almost black (Fig. 3J) in those from Arunachal Pradesh (Kemeng Division—above 1800 m.) and BHUTAN. Segments 4-11 are brown or dark brown (Fig. 3F & G) in those from Kerala, Tamilnadu, Maharashtra, Andhra Pradesh, Orissa, Uttar Pradesh and Bihar, whereas dark brown (Figs. 3H & I) in those from W. Bengal, Meghalaya, Assam, Arunachal Pradesh (Subansiri & Siang Divisions—below 1800 m.), NEPAL, BURMA and CHINA, and almost black (Fig. 3J) in those from Arunachal Pradesh (Kameng Division—above 1800 m.) and BHUTAN.

Remarks—Punctures on pronotum are gradually finer and sparser and colour of legs, palpi and antennae is gradually darker from south to north and from east to west.

INTERPOPULATION RELATIONSHIP (Fig. 4)

In order to have better understanding and to show relationship of the different populations of *Chlaenius bimaculatus* Dejean we need first to distinguish among plastic characters which are original and which are derived. Supposedly original characters are represented by white squares and derived characters by black squares. Cross-hatched squares indicate both original and derived conditions. The distribution of 7 selected characters are represented by the horizontal column, while 19 populations correspond to vertical rows.

DISCUSSION

Populations from Kerala, Maharashtra, Tamilnadu, Andhra Pradesh, Orissa, Uttar Pradesh (Lucknow) and Bihar represent *raoytus* Bates having reddish brown legs and coarsely and densely punctate pronotum, while those from W. Bengal (Berhampur), Meghalaya, Assam, Arunachal Pradesh (Subansiri and Siang Divisions—below 1800 m.), Burma and CHINA correspond to *bimaculatus* s. str. with yellowish femur, reddish tibiae and tarsi, and finely and sparsely punctate pronotum. The name *ocellatus* of Andrewes, as shown by its type locality, applies to the population from Madhya Pradesh which is also similar to that of Uttar Pradesh (Dehra Dun & Haridwar). *C. ocellatus* appears to be intermediate between *rayotus* and *bimaculatus*. But

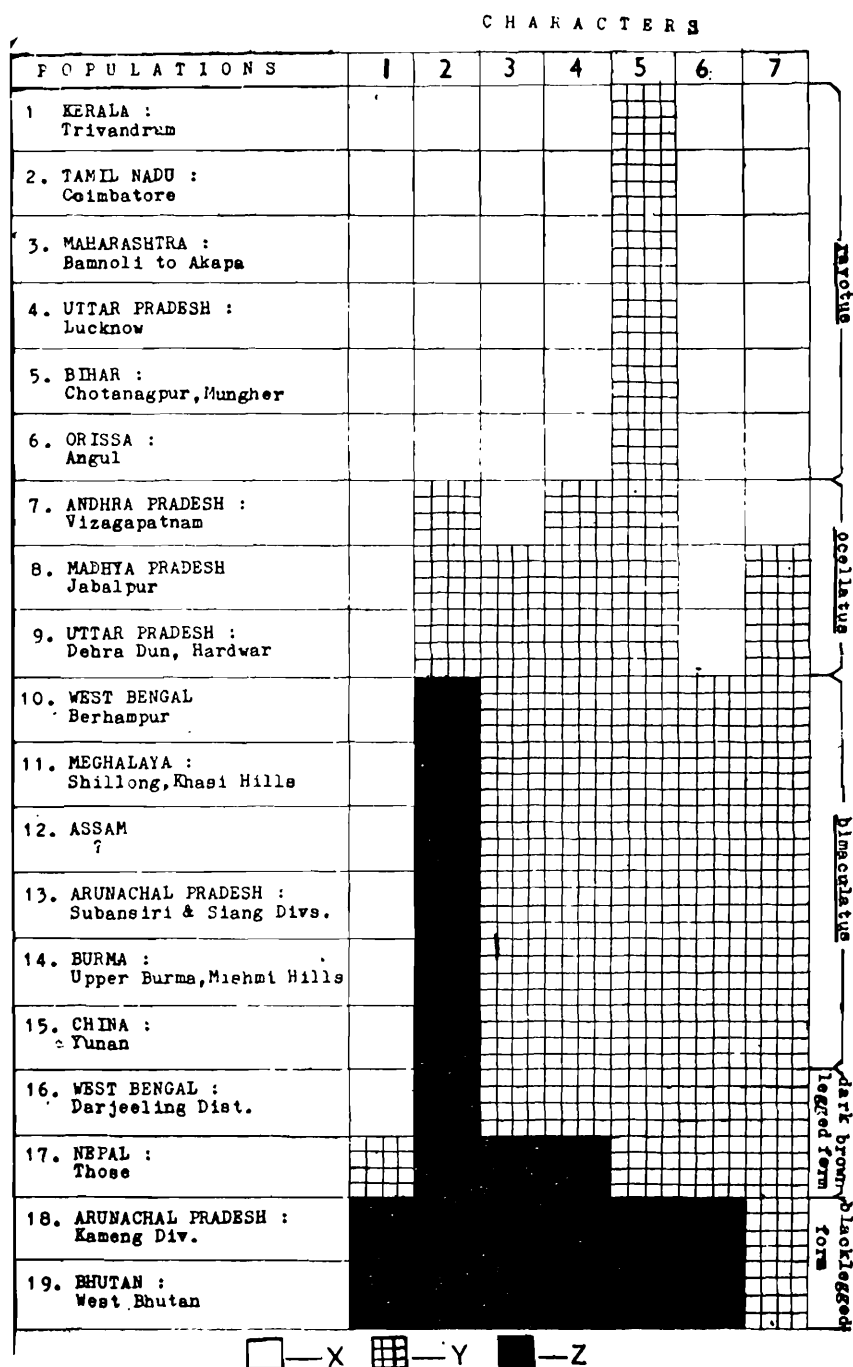


Fig. 4 Checkerboard type of distribution of characters showing interpopulation relationship of *Chlaenius bimaculatus* Dejean.

Characters used in the Checkerboard: (X=white squares, Y=cross-hatched squares, Z=black squares.)

1. *Punctuation on pronotum*
coarse and dense—X
moderately coarse and dense—Y
fine and sparse—Z
2. *Colour of tibiae and tarsi*
reddish brown—X
brown—Y
dark brown or black—Z
3. *Colour of palpi*
wholly reddish brown, or dark brown with apices of apical segments narrowly pale—X
brown or dark brown with apices of apical segments broadly pale—Y
wholly dark brown, or black with apices of apical segments broadly and basal half of subapical segments pale—Z
4. *Colour of femur*
wholly reddish brown—X
yellowish brown with apex brown or dark brown—Y
wholly dark brown or black—Z
5. *Colour of antennal segments 4-11*
reddish brown—X
brown or dark brown—Y
black—Z
6. *Colour of antennal segments 2+3*
reddish brown—X
dark brown—Y
black—Z
7. *Colour of antennal segment 1*
reddish brown—X
yellowish brown or brown—Y
black—Z

one specimen from Andhra Pradesh approaches the appearance of *ocellatus* by its yellowish brown femora and narrowly pale apices of apical segments of palpi suggests that intergradation occurs there, which might be expected in the areas where the tributaries of Andhra Pradesh lie near Madhya Pradesh. So the relationship of *ocellatus* with *rayotus* and *bimaculatus* will remain obscure untill large series of examples of expected heterogenous populations can be obtained. Populations with dark brown legged examples from W. Bengal (Darjeeling dist.) and NEPAL probably represents a different form and is intermedicate between *bimaculatus* and another different form with black legged examples from Arunachal Pradesh (Kameng Division—above 1800 m.) and BHUTAN.

Geographic variation in *C. bimaculatus* is complex and difficult to treat taxonomically. Although some well marked categories occupy the parts of the range of the species, some of them appear to display considerable variation within the same area. Moreover some areas are occupied by what appear to

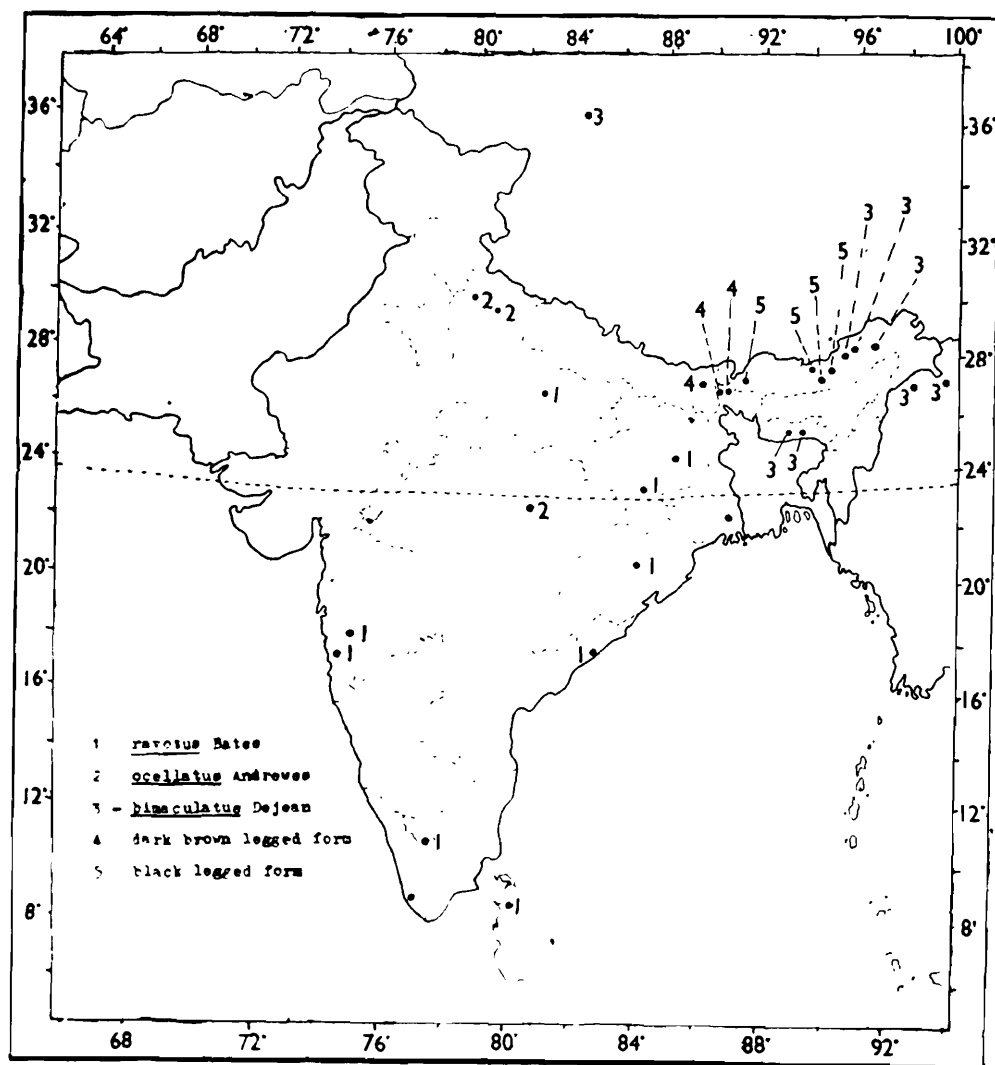


Fig. 5. Map showing distribution of different forms of *Chlaenius bimaculatus* Dejean (distribution in Laos and Malaya Archipelago not shown).

be hybrid populations. Naming of any subspecific categories until the relationship of populations from the other regions of South East Asia is completely known would appear untenable.

ACKNOWLEDGEMENTS

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INTRA-SPECIFIC VARIATIONS IN INSECTS WITH SPECIAL REFERENCE TO THE CHEWING-LICE (PHTHIRAPTERA)

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The variation in biological communities leads to speciation, and there by evolution, which is the spice of life. No two individuals in Nature are alike, since every organism reacts in its own way to the abiotic and biotic fluctuations in the environment that surrounds it, which is responsible for the inter-and intra-specific variations. These variations may be temporary or permanent when they are inherited in a true Mendelian fashion. The temporary variations on the other hand are transient such as the teratological variations which do not occur time and again in the species as a whole. The permanent variations, whatever may be the causative factor, such as the environmental effects, hormonal physiology, etc., must be followed by a genetical change or *vice versa* for those variations to appear again and again in a population or species.

Generally the variations are measurable qualitatively or quantitatively. Mayr (1969) grouped the intra-specific variations into I. Non-genetic variation, and II. Genetic variation. According to this author, the former category includes the following: Individual variation in time (due to age, individual variation due to the season, and cyclic variations in the generations), Social variation (insect castes), Ecological variation (due to habitat climate, host determined, population density, allometric, and neurogenic colour variation) and lastly the Traumatic variation (due to parasitic effect and teratological variations). The Genetic variations are sex associated (due to primary or secondary differences in the sexes, alternation of generations, gynandromorphs or intersexes) and non-sex associated (which may be continuous or discontinuous, or genetic polymorphism.)

Of these factors, for taxonomic purposes in Phthiraptera we normally consider the following characters : size, structure, colour, host or climate induced factors.

SIZE

The chewing-lice are obligatory ectoparasitic insects on birds and mammals, and the size is the most common variation amongst them. The females are generally larger than males, although certain individual organs like the antenna may be larger than the counterpart in the female as in *Goniodes*,

Lipeurus, *Oxylipeurus*, etc., especially in the suborder Ischnocerophthirina. The populations found in tropical climate tend to be smaller than the corresponding ones in the temperate regions like Poland ; thus these populations are following the traditional Bergmann's law that larger individuals are found in the cooler climates (Clay, 1949 ; Lakshminarayana, 1977). In fact, it is the host species which follows this principle to a greater degree in terms of growth and health, and the larger the birds are, the lower their body temperatures as compared to the individuals of the same species inhabiting hotter climates. The lice on the larger birds, with lower body temperatures (also perhaps with better health), find the host more conducive for development, and therefore, grow to a larger size than those found on smaller individuals with higher temperature, in the hotter climates. When the host is sickly as in domestic fowl and heavily infested by one or more species of lice, the latter tend to be smaller. Teneral forms are also slightly smaller than the mature adults. One should carefully weigh the size variation in the taxonomy of this group, and at best it serves as a supplementary character.

STRUCTURE

For any taxonomist, the morphology of the specimen before is the most important attribute. At times, we find some asymmetrical or abnormal individuals in the populations of the lice. These abnormalities may be temporary and restricted to a particular instar, or may be found in all the instars. They are the results of healing of mechanical injuries caused by the host preening operations. The teratological asymmetry has been discussed elsewhere (Lakshminarayana, in press)

The chewing-lice are clothed with setae and the variation in the number and size has been given very heavy weightage in the past. It is known that certain setae are often present or associated with certain structures constantly and are very important either subspecifically, specifically and even generically also. To quote a few, the head setae in Amblycerophthirina (Clay 1962, 1966, 1969, 1970) ; and *Laemobothrion*-complex (Amblycerophthirina the modified head setae in *Anatoecus*, *Columbicola*, *Anaticola* (Ischnocerophthirina) the setae on the antennal segment in the male *Goniodes-Goniocotes* complex ; the tubercular setae on sternite II in *Myrsidea* the postspiracular setae ; and the tuberculate setae on the ventrolateral edge of the IX and the setae and spines on the female genital region in *Goniodes*, segment in *Rallicola*-complex, may be cited. But there are other setae which vary from not only individual to individual but also from segment to segment, and on the right and left sides. These variations are very trivial and should not be banked in distinguishing the species from a population when other morphological characters are common to all of them.

Certain structural characters like presence or absence of maxillar palpi, number of antennal segments, nature of mandibles, position and shape of the spiracles, presence of gonapophyses, presence of ctenidia or comb rows, are either subordinal, family, generic, specific, and even subspecific importance. The presence of a U-shaped structure and holes on the sitophore sclerite are useful characters for identification of different populations at a glance (Nelson & Price, 1965, Lakshminarayana, 1968, 1970), the shape of gular plate in *Pseudomenopon* (Clay, 1969; Price, 1974) is also an important character. Variation on the head outline, and the number and nature of setae on II abdominal sternite in *Degeeriella* and *Myrsidea* respectively have been given over emphasis in distinguishing species from different populations of the same species. The structure of male genitalia is however, will be very helpful in distinguishing species from populations of sympatric species.

COLOUR

The insect colouration may be structural, or pigmental origin or a combination of both, and follow the VIBGYOR principle in colour production. The structural colouration is due to the arrangement of scales, fluting or grating of the cuticle. The metallic colouration is due to diffraction, interference, or Tyndall effect (as in the blues of Odonates), or selective reflection. The pigment colouration is due to the presence of B-Carotenoids, astaxanthin, insectorubin, insectoviridin, melanin, flavones, and occasionally by the dissolved haemoglobin as in Chironomid larvae. The structural colouration is essentially a genetic factor, while the pigment colouration may be gene controlled and the resultant production of aminoacids and proteins, or influenced by the climate, crowding, or other physiological causes. In Phthiraptera the colour variation is not of much importance being light to dark brown and black, although certain blotches, spots, and bands are occasionally of important nature in distinguishing populations and species. Members of *Myrsidea* parasitic on Icteridae often show brilliant colouration, due to reflection of the semi-digested iridescent feathers of the host.

SEX-ASSOCIATED VARIATIONS

Certain variations are associated with sex, for example, the Gonapophyses of the Trichodectid female, male antenna of *Goniodes*, *Lipeurus*, *Oxylipeurus*-Complex, mandible in the female *Ornithoephechthos* (Lakshminarayana, 1970, Lakshminarayana, 1979), or the setae and pockets found on abdominal female segment of *Cavifera* (Price & Clay, 1970). When such variants occur in a species, a taxonomist may name them separately if only a single sex is available for his study; it is not desirable to describe the species on the basis of one sex alone, except when that genus/ or species exhibit

diagnostic characters more either in the male or female. More often, we encounter more than one species belonging to different genera or populations of sympatric species on a given host, therefore, one should be very careful while describing a species basing on one sex alone.

HOST OR CLIMATE INDUCED VARIATIONS

Populations found on host species in different ecological zones are likely to vary. Intra-specific variations can be fixed by studying a series of populations from different geographical ranges, or by breeding experiments. The biology of very few species have been studied and because of the obligatory nature of the chewing-lice, in the absence of *vitro* techniques in rearing, it is difficult to study the biology of many species found specially on the wild hosts. Generally, the females outnumber males, and in few instances the males are extremely rare and the females are believed to be parthenogenic (Hopkins, 1949). We know amongst insects, that individuals undergoing diapause and those of non-diapausing broods not only show variation in the structure, colour, etc., but also in the colour of the eggs (for ex., *Bombyx mori*) and their respective hatching intervals also differ. We are not aware whether any populations of chewing-lice undergo diapause or not, but it may be expected in populations occurring on the migratory host species; likewise, the effect of photo-period is not known. Since the chewing-lice inhabit the feather or hair cover, their microclimatic variations may be negligible as compared to the environmental fluctuations to which their hosts are subjected. But those species that inhabit the head region of the birds are liable to be exposed to more heat and light because of the sparse feathers in this region, and certainly some influence of climatic heat or photo-period effect may be there on these forms.

ACKNOWLEDGEMENT

The author is grateful to the Director, Z. S. I., for all the facilities and encouragement.

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VARIABILITY IN SIZE AND MORPHOMETRIC ANALYSIS OF
THE SOLDIER CASTE IN *HETEROTERMES INDICOLA*

(WASMANN) (RHINOTERMITIDAE :
HETEROTERMITINAE)

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INTRODUCTION

The soldier caste in some species of *Heterotermes* is reported to be dimorphic. Of the five species of the genus known from the Indian subregion, the dimorphic soldier caste (*i.e.*, soldier major and soldier minor) is reported in the species *H. indicola* (Wasmann) and *H. ceylonicus* (Holmgren). During the course of the study of some collections of *H. indicola*, it was observed that the so called two types of soldiers *i.e.*, major and minor were linked up by intermediates and a morphometric analysis of the soldier caste was undertaken to ascertain whether dimorphism really occurred in the soldier of *H. indicola* or not.

The authors are grateful to the Director, Zoological Survey of India, for his keen interest and encouragements during this study and to Shri G. D. Mukherjee for help in statistical analysis.

MATERIAL AND METHOD

Two population samples of 90 and 50 individual soldiers, of *Heterotermes indicola*, from Calcutta, West Bengal (population A) and Dhaneta, 15 Km N. of Jawalamukhi, Himachal Pradesh (population B), respectively were taken up for study.

The following body parts of each of the individual soldier were measured and indices determined.

(a) *Measurements*

1. Length of head to lateral base of mandibles
2. Maximum width of head
3. Length of left mandible from upper base of condyle to tip
4. Median length of postmentum
5. Maximum width of pronotum

(b) Indices

1. Head index, width/length
2. Mandible-head index, left mandible length/head-length to lateral base of mandibles
3. Postmentum-head index, median length of postmentum/head-length to lateral base of mandibles
4. Pronotum-head width index, maximum width of pronotum/maximum width of head

The measurements were taken under stereo-binocular microscope with the help of an eye-piece micrometer in accordance with the definitions given by Roonwal (1970) and statistically analysed by using large sample theory test.

MORPHOMETRIC ANALYSIS

The head-length varied from 1.33-1.77 mm (mean value 1.505 mm) and from 1.33-1.77 mm (mean value 1.545 mm), the head-width from 0.83-1.00 (mean 0.888) and 0.87-1.00 (mean 0.944), the left mandible length from 0.83-0.93 (mean 0.874) and 0.80-0.93 (mean 0.868), the postmentum length

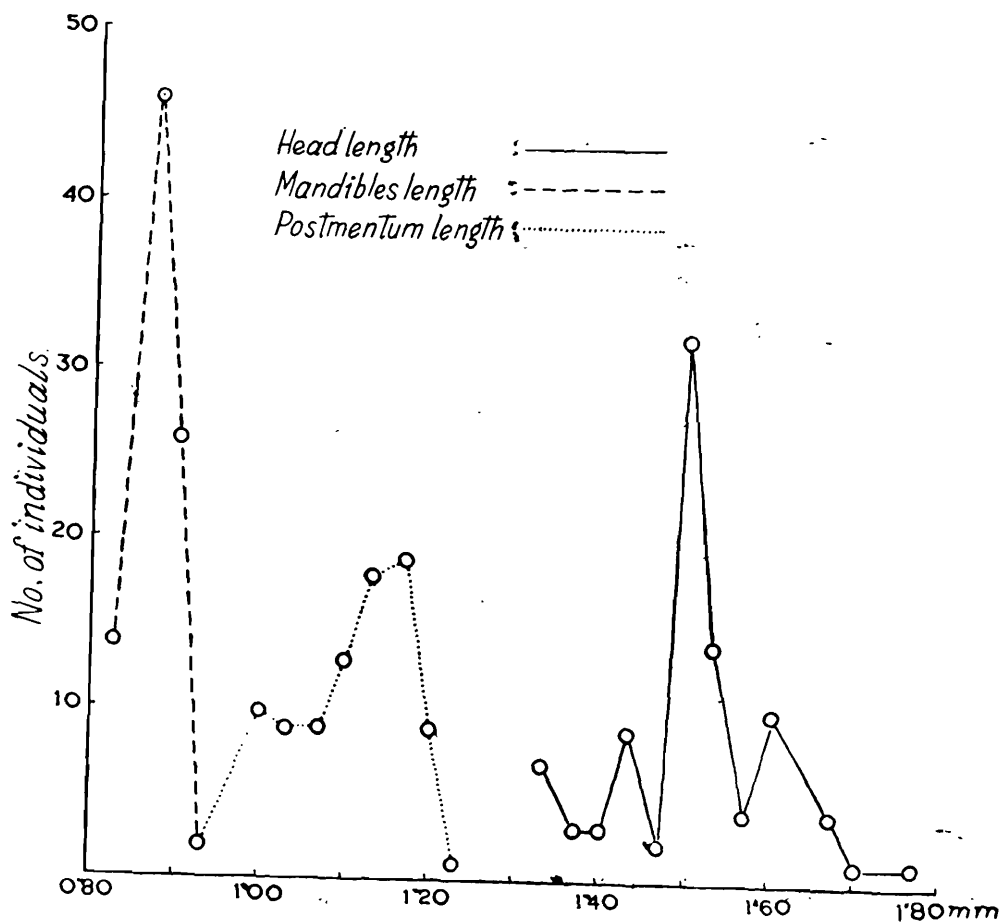


Fig. 1. Graph showing variation in the length of head, mandibles and postmentum of soldiers of *Heterotermes indicola* (Wasmann) in population 'A' from Calcutta (West Bengal).

from 0.93-1.23 (mean 1.111) and 0.93-1.23 (mean 1.098) and the pronotum width 0.67-0.83 (mean 0.699) and 0.67-0.80 (mean 0.722), respectively in populations A and B.

Of the 90 individuals, measured in population A (Figs. 1 and 2; Table 1), the frequency of measurements was as follows :—Length of head to lateral base of mandibles : 7 individuals (1.33 mm), 3(1.37), 3(1.40), 9(1.43), 2(1.47), 32(1.50), 14(1.53), 4(1.57), 10(1.60), 4(1.67) and 1 each (1.70 and 1.77); maximum width of head : 10 individuals (0.83 mm), 29(0.87), 41(0.90), 7(0.93), 1(0.97) and 2(1.00) ; length of left mandible : 14 individuals (0.83 mm), 48(0.87), 26(0.90) and 2(0.93); median length of postmentum : 2 individuals (0.93 mm), 10(1.00), 9 each (1.03 and 1.07), 13(1.10), 18(1.13), 19(1.17), 9(1.20) and 1(1.23) ; and maximum width of pronotum : 37 individuals (0.67 mm), 28(0.70), 21(0.73) and 2 each (0.77 and 0.83).

In population B (50 individuals) (Figs. 3 and 4 ; Table 1), the frequency of measurements was thus :—Length of head to lateral base of mandibles : 2 individuals (1.33 mm), 4(1.40), 6(1.43), 18(1.50), 5(1.60), 9

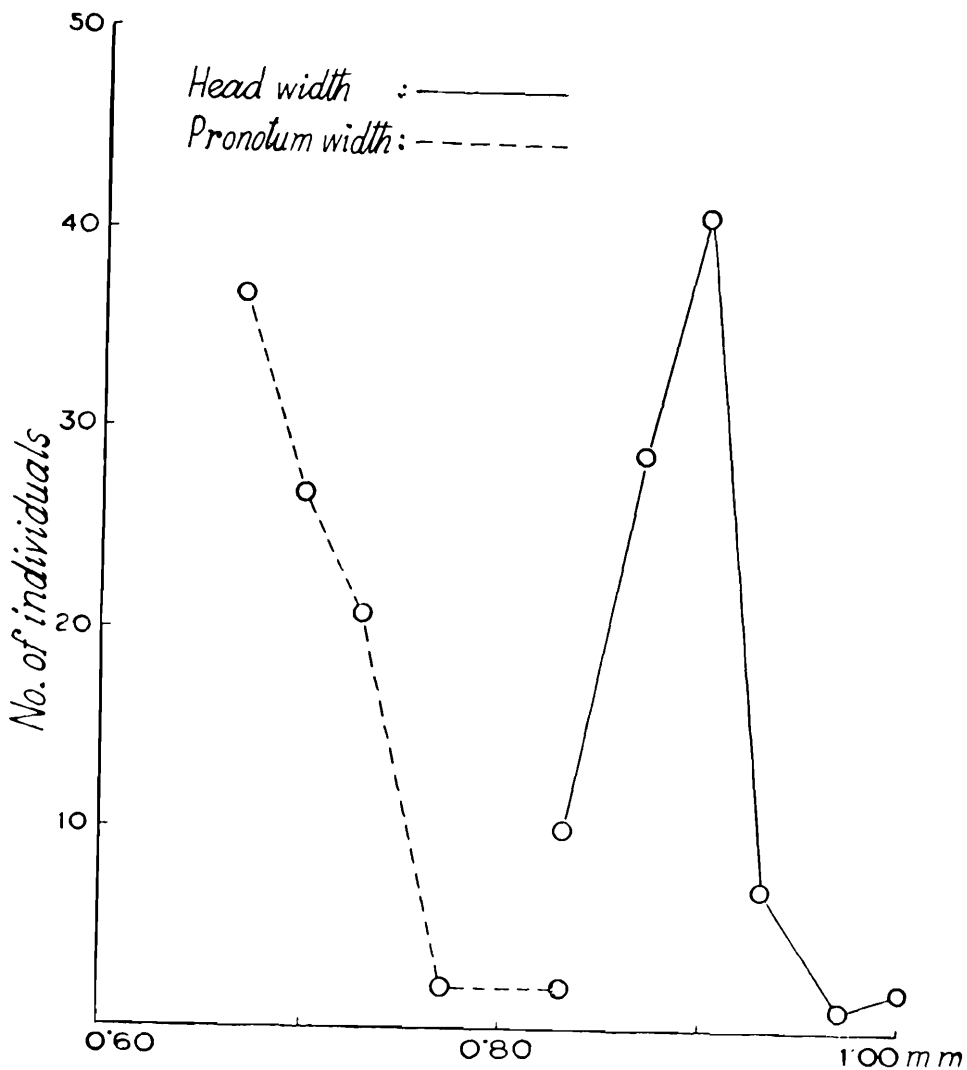


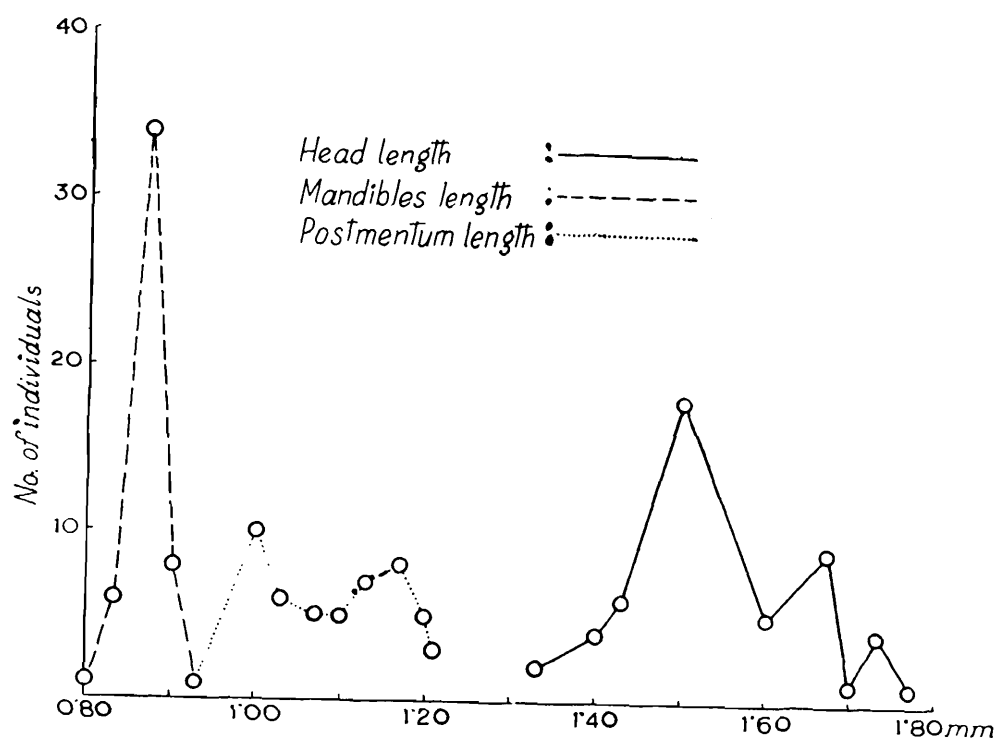
Fig. 2. Graph showing variation in the width of head and pronotum of soldiers of *Heterotermes indicola* (Wasmann) in population 'A' from Calcutta (West Bengal).

TABLE 1. Measurements (in mm) of some body parts of the soldier caste from two different populations of *Heterotermes indicola* (Wasmann) and their statistical constants.

S. D., Standard deviation ; S. E., standard error ; C.V., coefficient of variation

Populations	Statistical analysis	Body parts				
		Length of head	Width of head	Length of left mandible	Median length of postmentum	Max. width of pronotum
Population 'A' from Calcutta, West Bengal (90 individuals)	Range	1.33-1.77	0.83-1.00	0.83-0.93	0.93-1.23	0.67-0.83
	Mean \pm S.E.	1.5046 \pm 0.0091	0.8884 \pm 0.0033	0.8738 \pm 0.0025	1.1111 \pm 0.0075	0.6992 \pm 0.0104
	S.D. \pm S.E.	0.0864 \pm 0.0064	0.0318 \pm 0.0023	0.0239 \pm 0.0017	0.0711 \pm 0.0052	0.0990 \pm 0.0074
	C.V. %	5.7430	3.5770	2.7310	6.3950	14.1640
Population 'B' from Dhaneta, 15 km North of Jawalamukhi, Himachal Pradesh (50 individuals)	Range	1.33-1.77	0.87-1.00	0.80-0.93	0.93-1.23	0.67-0.80
	Mean \pm S.E.	1.5452 \pm 0.0162	0.9444 \pm 0.0053	0.8678 \pm 0.0034	1.0984 \pm 0.1110	0.7222 \pm 0.0053
	S.D. \pm S.E.	0.1148 \pm 0.0114	0.0375 \pm 0.0037	0.0241 \pm 0.0024	0.0785 \pm 0.0078	0.0374 \pm 0.0037
	C.V. %	7.4320	3.9750	2.7740	7.1500	5.1784

(1.67), 1(1.70), 4(1.73), 1(1.77) ; max. width of head : 1 individual each (0.80 and 0.87 mm), 9(0.90), 21(0.93), 6(0.97) and 12(1.00) ; length of left mandible : 1 each (0.80 and 0.93 mm), 6(0.83), 34(0.87) and 8(0.90) ; median

Fig. 3. Graph showing variation in the length of head, mandibles and postmentum of soldiers of *Heterotermes indicola* (Wasmann) in population 'B' from Dhaneta (Himachal Pradesh).

length of postmentum : 1 individual (0.93 mm), 10(1.00), 6(1.03), 5 each (1.07, 1.10 and 1.20), 7(1.13), 8(1.17) and 3(1.23) ; and max. width of pronotum : 10 individuals (0.67 mm), 7(0.70), 24(0.73), 5(0.77) and 4(0.80).

All the measurements taken were depicted on graphs separately for the two populations.

The data of the two populations were statistically analysed for various statistical constants. The mean values of the left mandible length and median length of postmentum were not found to be significantly different. The length of head and width of pronotum were significantly different at 5 per cent level of probability and the width of head at 0.1 per cent level of probability.

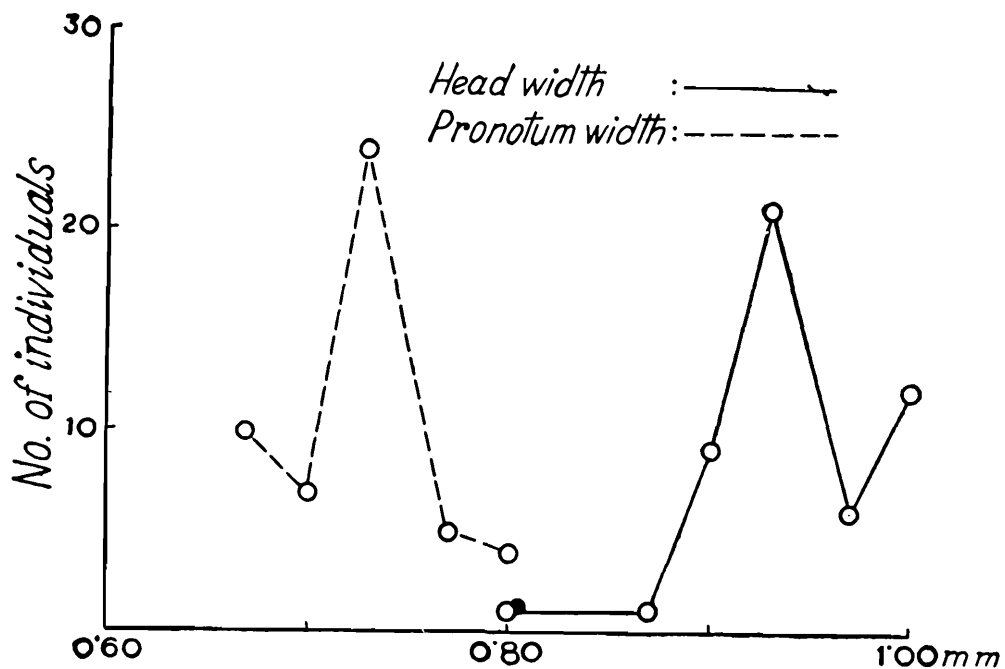


Fig. 4. Graph showing variation in the width of head and pronotum of soldiers of *Heterotermes indicola* (Wasmann) in population 'B' from Dhaneta (Himachal Pradesh).

The head index (width/length) varied from 0.521-0.654 (mean 0.599) and 0.539-0.699 (mean 0.613), the mandible-head index (left mandible length/head-length to lateral base of mandibles) from 0.497-0.654 (mean 0.595) and 0.479-0.624 (mean 0.566), the postmentum-head index (postmentum length/head-length to lateral base of mandibles) from 0.659-0.827 (mean 0.747) and 0.667-0.774 (mean 0.712) and the pronotum-head index (max. pronotum-width/max. head-width) from 0.720-0.856 (mean 0.796) and 0.700-0.856 (mean 0.770), in populations A and B, respectively.

CONCLUSIONS

From the foregoing data and frequency distribution graphs it is noticed that in case of both the populations of this species, the different characters, in general, show unimodal peak in respect of the number of individuals and the measurements. The minor fluctuations are probably due to the different population samples from widely separated localities. As such, it may be concluded that (i) the soldier caste is very variable in size, which presumably is due to the age of the individual soldiers and (ii) that the soldier caste is monomorphic in this species.

The presence of two differently sized soldiers and the paucity of the large, interconnecting series in the collections available to Holmgren (1913), most probably led him to presume that dimorphic soldier caste occurred in this species.

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INTRASPECIFIC DIVERSITY IN DERMAPTERA

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Intraspecific variations are a common feature in Dermaptera and for their study a large series is always necessary. In recent years as a result of careful collections made by the author as well his colleagues, a wealth of material has accumulated in the Zoological Survey of India, Calcutta from various parts of the country which has enabled him to take up the present study. However, observations made on the material received from various other museums have also been incorporated for the sake of completeness.

Burr (1910) in his volume under the *Fauna of British India* series, made casual references to variations occurring in certain species only. However, Hebard (1923) gave emphasis on this aspect and pointed out contrasts between brachylabic (shorter) and macrolabic (longer) forms of forceps in certain species and the corresponding changes that usually take place in various other organs such as pygidium, ultimate tergite and within narrow limits in pronotum in both phases.

An attempt has been made to provide an overall picture of various types of variations occurring intraspecifically, citing a few examples in each case.

Generally most of the species are uniformly coloured with varying intensity on different body parts. In some species elytra and wings are provided with spots and streaks which may be faint or completely absent in the individuals of the same species. For instance in a large population of *Elaunon bipartitus* (Kirby), it has been observed that the brownish stripe on elytra and wings along the sutural margin is normally distinct but sometimes very faintly represented or completely merges with brownish yellow background of elytra and wings. *Homotages feae* (Burr), possesses a characteristic yellowish brown or yellow spot in the middle of elytra in the majority of specimens in a given population but in some it is diffused, whereas in others it is not at all discernible. In *Allodahlia coriacea* (Bormans), wings are generally dark brown or blackish brown. But occasionally they are complete yellow and give totally different appearance to the specimen. Bey-Bienko (1959) who encountered such specimens in a collection from South China, gave them subspecific rank and named *A. coriacea signata* being restricted only in that area. The author has come across such specimens from Vietnam, Laos and India which clearly prove the contention of Stenmann (1975) that these specimens cannot be given the subspecific rank. In a large series often light brown or yellowish specimens can be occasionally seen. Such specimens have been often reported as yellow

variety as in the case of *Forficula schlagintweiti* (Burr). In fact these are freshly hatched specimens which have not attained normal skin colouration. It has been observed in the laboratory that freshly hatched specimens are whitish or yellow and it takes nearly six to twentyfour hours in acquiring the normal body colour.

Shape of head is generally constant intraspecifically but variations do occur in the size of eyes in relation to post-ocular length in some species. Amongst the Indian species this phenomenon has been observed in *Marava arachidis* (Yersin) and *Labia lutea* (Bormans). In the latter it has been recorded by Srivastava (1975) that in brachypterous form (with short elytra and wings absent) eyes are shorter (Fig. 3) whereas in macropterous forms (with elytra and wings fully developed) eyes are larger. Possible reason for enlargement in eyes may be in order to meet the demand of better vision as a result of increased locomotion of insect in the presence of fully developed organs of flight. Antennae are very fragile and often tend to break off easily with slightest jerk. For this reason total number of segments are seldom used in taxonomic studies. Some intraspecific variations have been, however, noted in the relative length of various segments of both sides in the same individual. Such instances are of course rare. This may be possibly due to deficient nourishment. The Pronotum is generally constant and is often used for the discrimination of related species. However, amongst the Indian species, in *Proreus simulans abdominalis* Ramamurthi and *Labia lutea* (Bormans), it has been found to vary within narrow limits, i. e., it may be either parallel sided or gently diverging posteriorly often with posterolateral angles prominent. Elytra and wings may be present or absent within the individuals of the same species. Besides it is not usual to find brachypterous (with elytra abbreviated and wings concealed below it) and normal forms within the same or different populations of a given species. It has been seen when elytra present it varies within narrow limits only. As such often its shape has been used in discriminations of various genera in the subfamily Opisthocosmiinae. Abdomen forms the bulk of the body and is armed on sides of certain segments with hooks or lobes in various species of the genera *Forcipula* Bolivar and *Eparchus* Burr (Fig.14). But it is not unusual to find within the population of same species some examples without such structures.

Usually it was thought the body punctation does not vary. In *Allodahlia macropyga* (Westwood) punctation is usually deep and dense but in 1 ♂, 1 ♀ it has been observed that punctation on the abdominal tergites is shallow and faint. However such instances are rare. Ultimate tergite shows some intraspecific variations in the development of tubercles situated above the roots of forceps. In *Oreasiobia fedtschenkoi fedtschenkoi* (Saussure), ultimate tergite is provided with two mammiform tubercles above the roots of forceps, which in some specimens become shorter and in others represented by faint elevations

only (Fig. 8). Such variations have not been recorded earlier in this species. In another related species *A. stoliczkae* (Burr), such similar variations have been recorded earlier (Fig. 9). In the genus *Forficula* L., only low tumid elevations are present in middle, corresponding the bases of forceps. Large populations of various Indian species of this genus reveal that not much variation exist as far as the shape and size of elevations on the ultimate tergites are concerned. Pygidium in both sexes varies greatly. It is a chitinous plate situated between the bases of forceps and its, free posterior margin is variously shaped intraspecifically. Usually in females it is less conspicuous. But in females of certain genera of the family Chelisochidae it is equally prominent. The discrimination of various species of the genus *Adiathetus* Burr based upon female pygidium, is more easy as compared to any other morphological character. In some species, for example, in *Labia lutea* (Bormans) (Figs. 4, 5) and *Irdex nitidipennis* (Bormans), pygidium shows great variations intraspecifically in shape and the degree of development with various intermediate stages as well. But in the majority of species such variations have not been probably recorded owing to the paucity of material. However, some species, namely *Chaetospania thoracica* (Dohrn), of which a large series has been examined by the author, do not exhibit much variation in the shape of pygidium. For this reason this structure is being used in differentiation of various species of different genera of Dermaptera.

Forceps are the most characteristic as well as plastic organs in these insects. These are generally variously armed in males and in females simple and straight. Moreover, in males, these show polymorphism and allometric growth. In the females in the families Chelisochidae (Figs. 6, 7) and Forficulidae (Figs. 10 to 13) individuals with shorter forceps (forma cyclolabia) and longer forceps (forma macrolabia) are commonly met with. In the family Diplatyidae, which is considered to be primitive, forceps may be slender and straight (forma macrolabia) or robust and strongly curved (forma macrolabia) but there is no difference in length. The members of the genus *Forficula* L., posses forceps with internal margin deplanate in basal one third to three fourth. It has been found during the course of study that modifications in forceps sometimes lead to some modifications in the ultimate tergite and the shape of pygidium. Therefore this fact should always be borne in mind while determining Dermaptera. Occasionally one branch of forceps may be deformed or shortened which perhaps may be due to injury at the time of final ecdysis or malnutrition.

Thus from the foregoing account it becomes amply clear that intraspecific variations are quite far flung and distinct. But this is not the case in the majority of the species. Besides, it is also not necessary if one species in a particular genus is very plastic others should also behave in the same manner. For instance in *Irdex nitidipennis* (Bormans), eight to nine varieties of pygidium (Srivastava, 1978, p. 270) are found but the shape of this plate varies within

very narrow limits in other species of the genus and is generally used for the discrimination of various species in allied genera as well.

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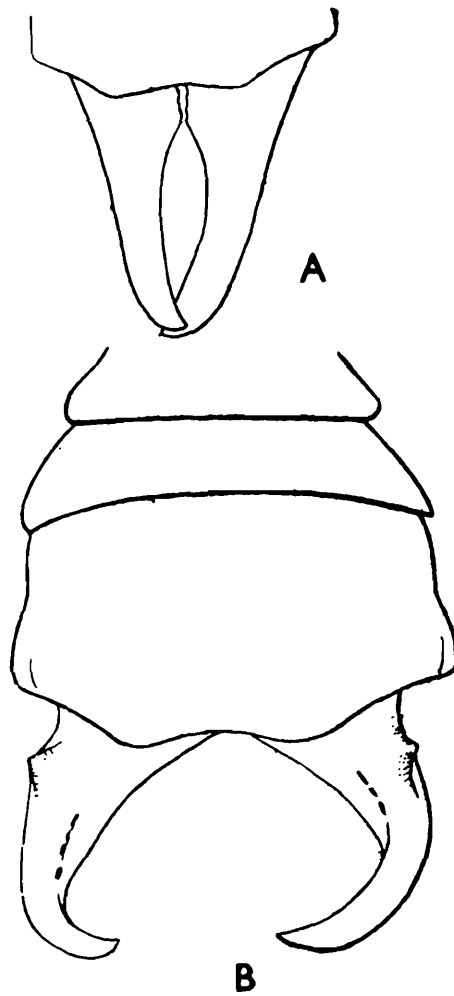


Fig. 1. Ultimate tergite and forceps of *Diplatys gladiator* Burr ♂ ; A. Microlabic form, B. Macrolabic form.

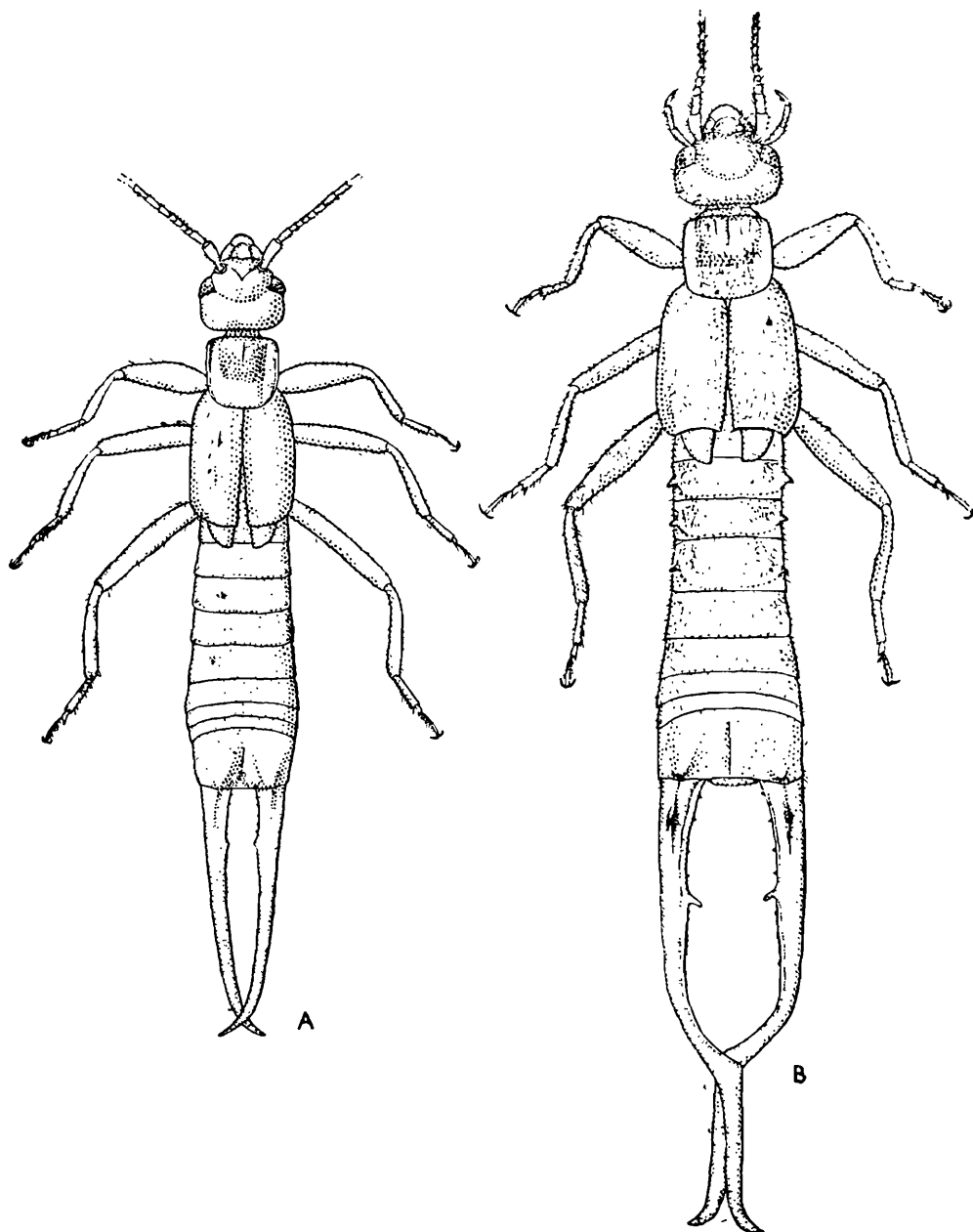


Fig. 2. *Forcipula trispinosa* (Dohrn) ♂ ; A. Showing sides of abdominal segments without spines. B. Showing spines on the sides of abdominal segment,

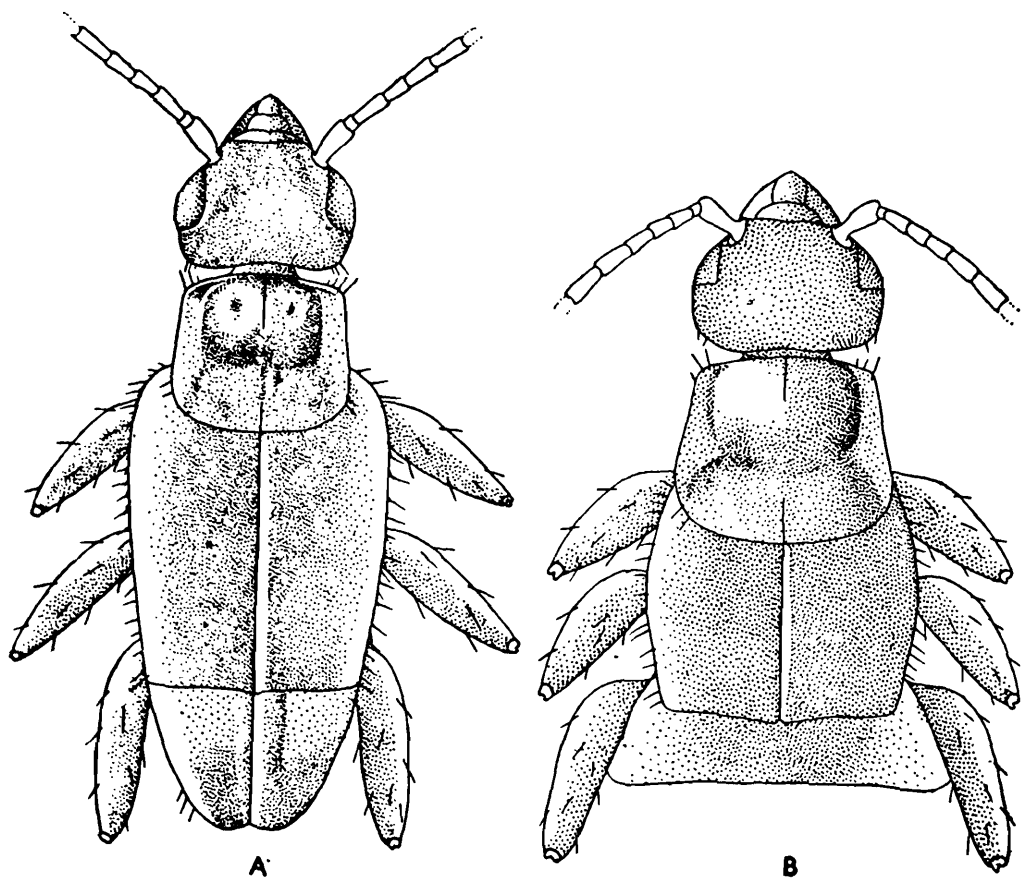


Fig. 3. *Labia lutea* (Bormans) ♂, anterior part of body : A. Showing marcopterous form with eyes longer than genae. B. Showing brachypterous form with eyes smaller than genae in length.

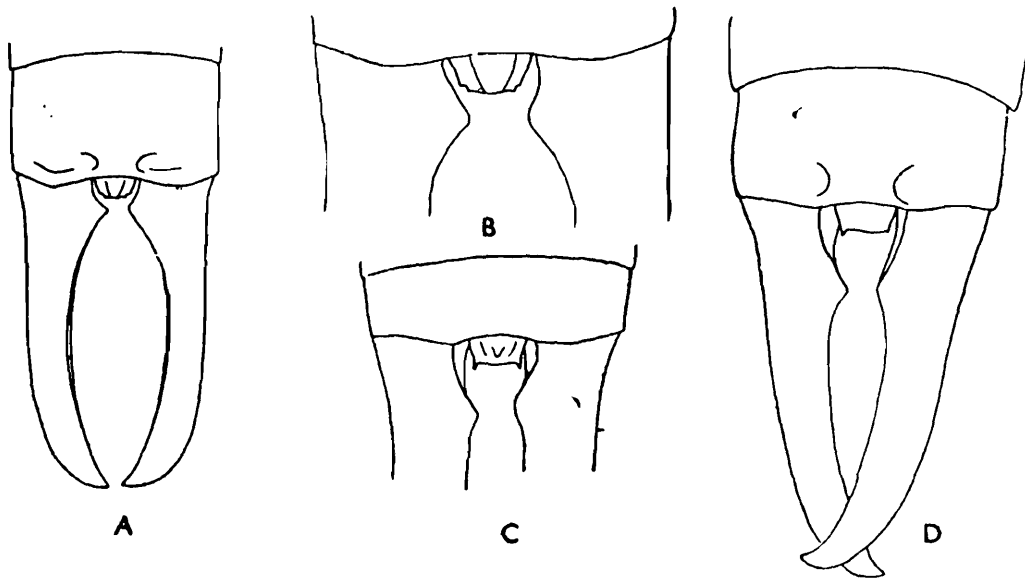


Fig. 4. A-D. *Labia lutea* (Bormans) ♂, Ultimate tergite and forceps showing variation in pygidium and forceps.

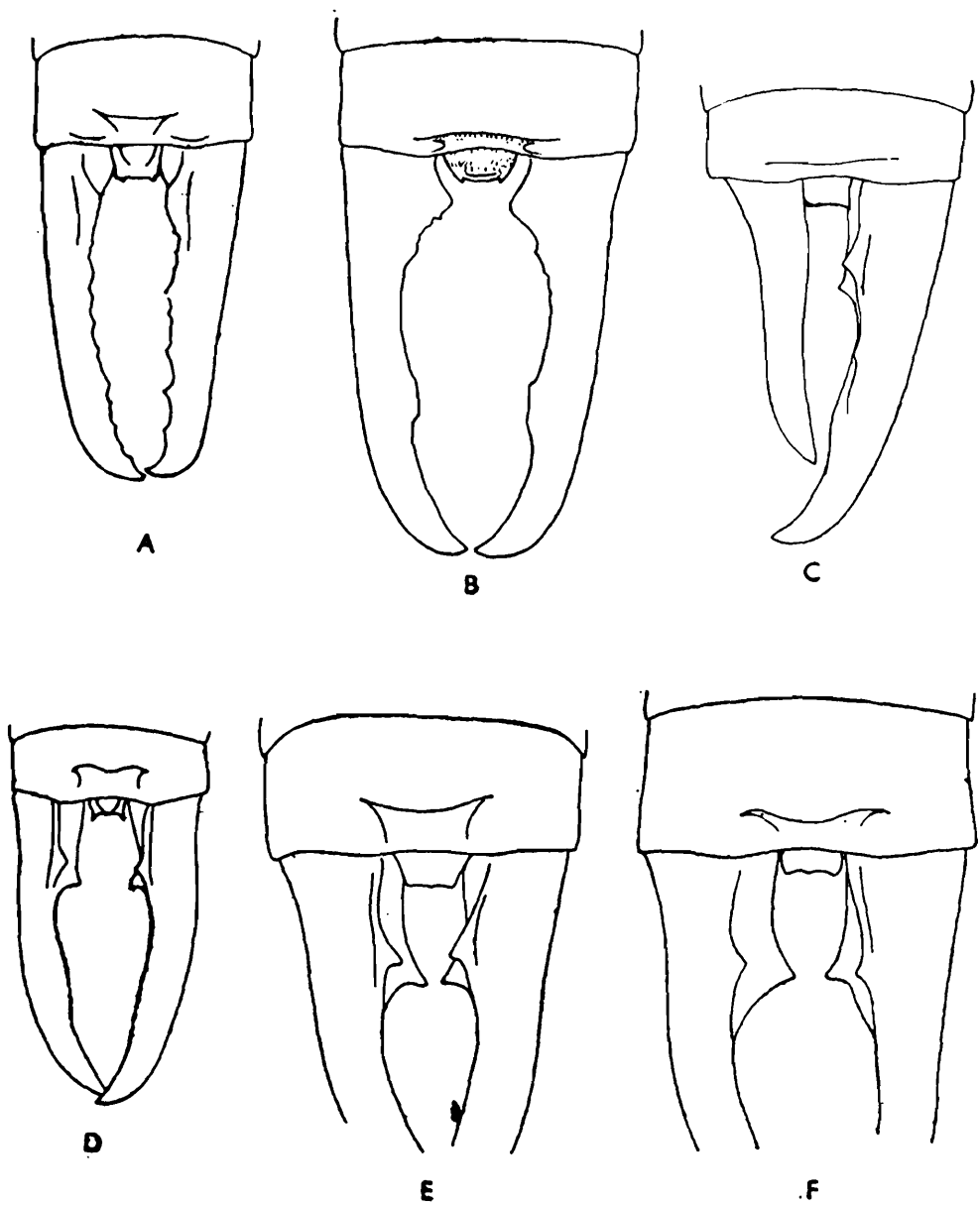


Fig 5. A-F, *Labia lutea* (Bormans) ♂ , Ultimate tergite and forceps showing variation in pygidium and forceps.

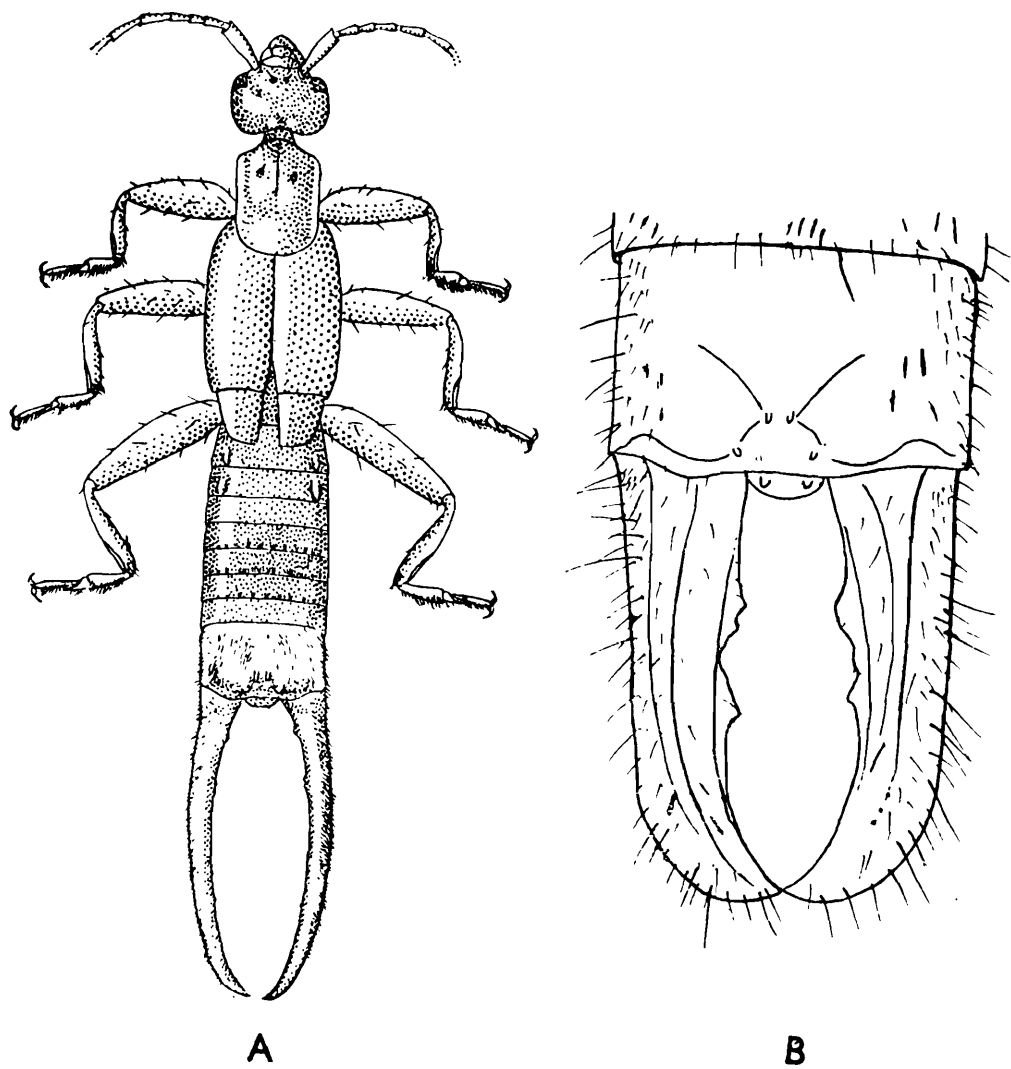


Fig. 6. *Hamaxas kempii* Burr ♂ : A. Dorsal view with macrolabic form. B. Ultimate tergite and forceps with cyclolabic form.

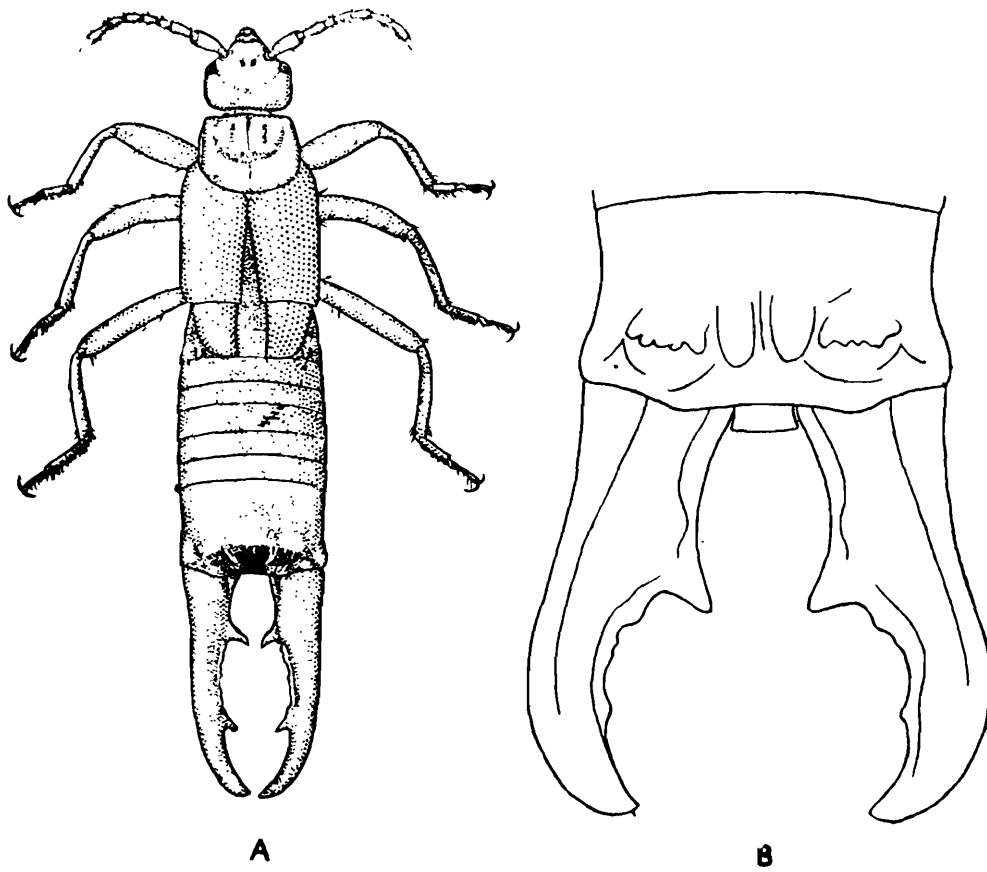


Fig. 7. *Adiathetus glaucopterus* (Bormans) ♂ : A. Dorsal view with macrolabic form, B. Ultimate tergite and forceps with brachylabic form.

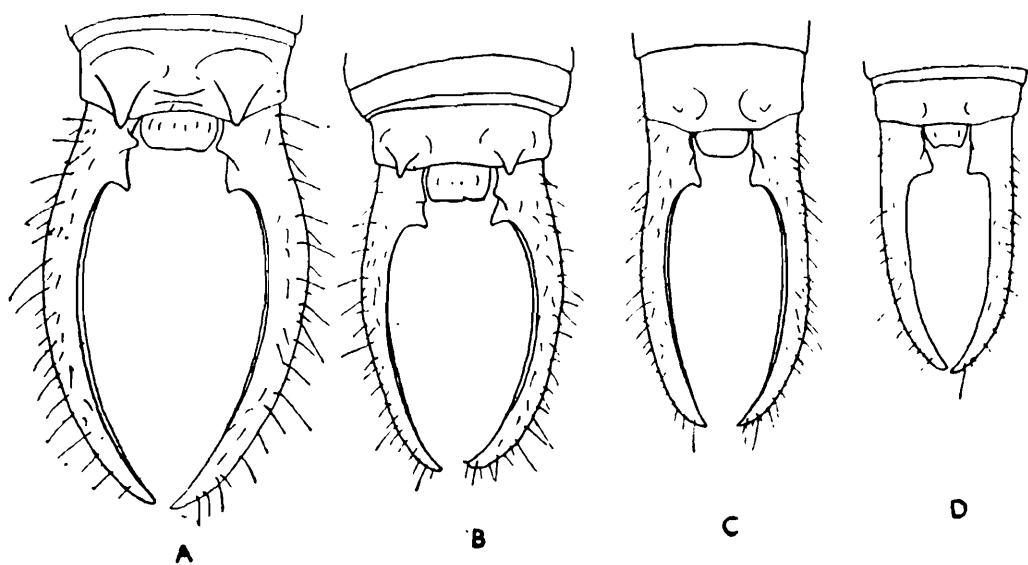


Fig. 8. A-D. *Oreasiobia fedtschenkoi fedtschenkoi* (Saussure) ♂, Ultimate tergite and forceps showing variations.

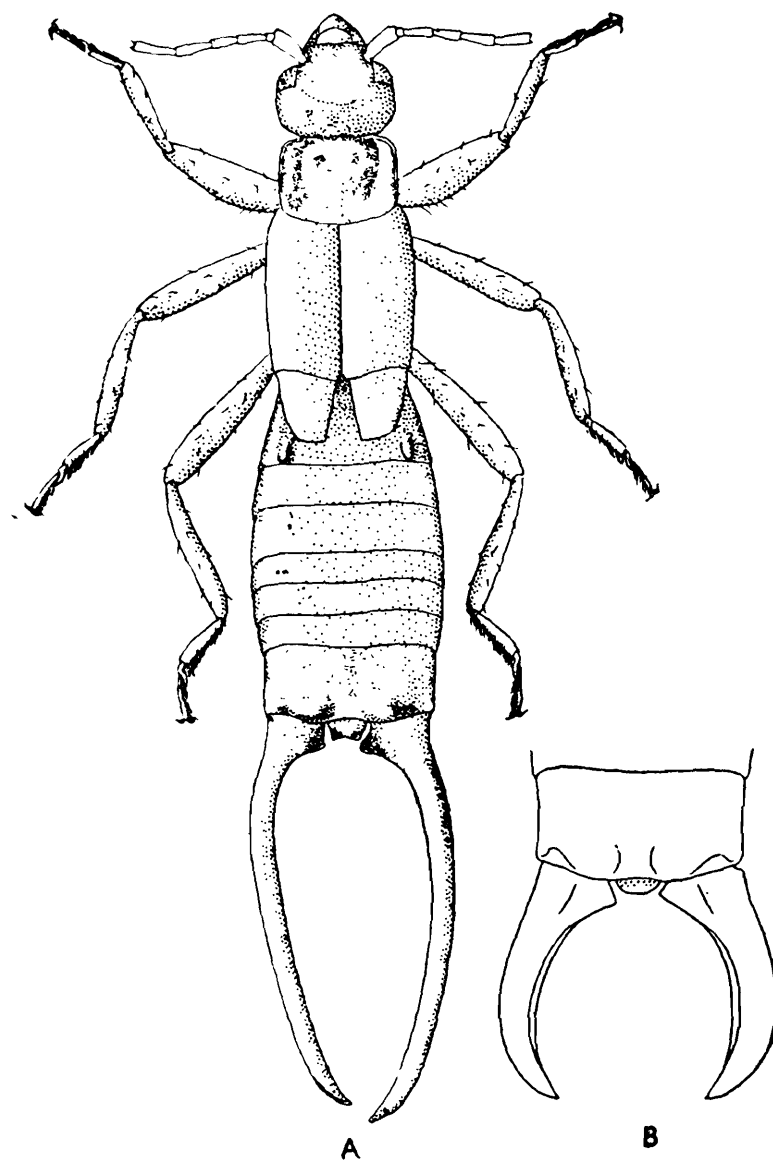


Fig. 9. *Anechura stoliczkae* (Burr) ♂, A. Dorsal view with macrolabic form, B. Ultimate tergite and forceps with cyclolabic form.

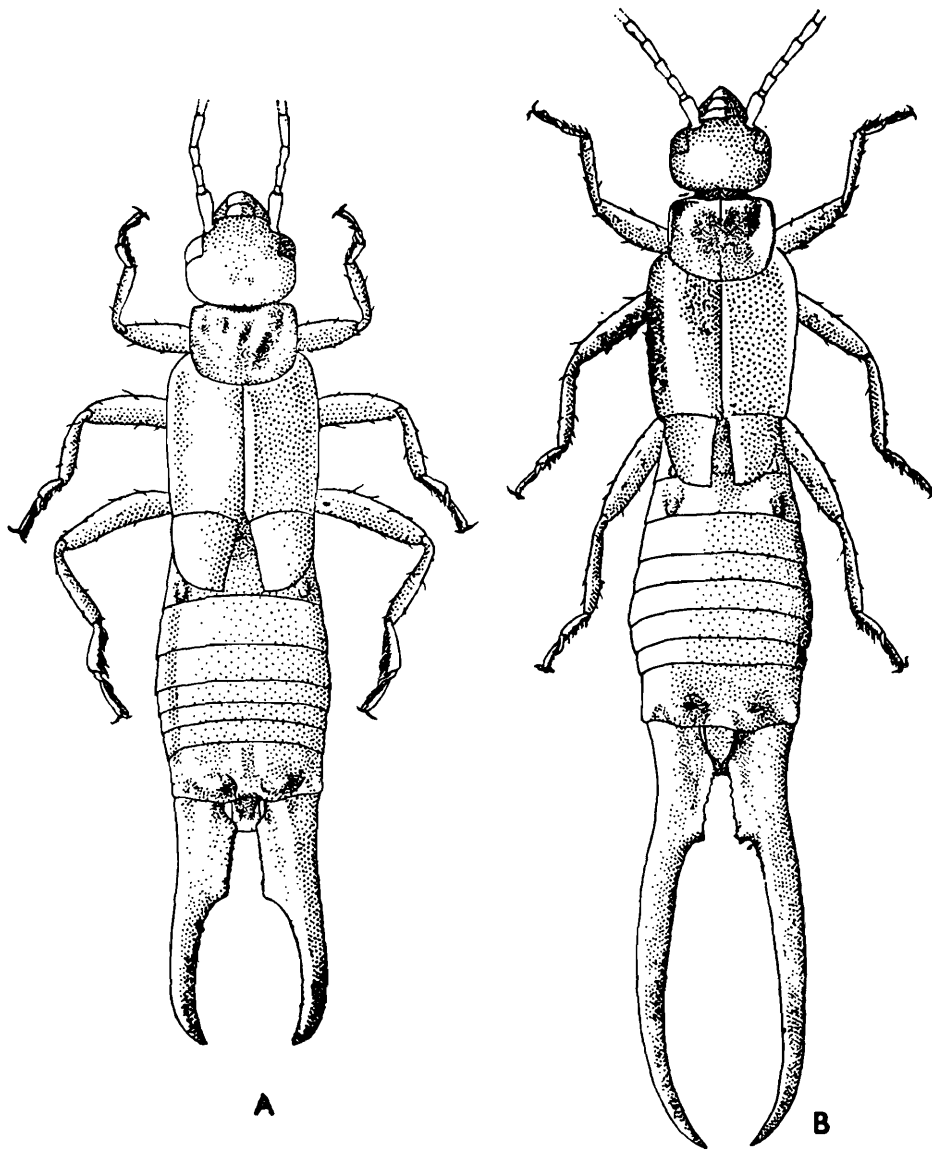


Fig. 10. *Forficula beelzebub* (Burr) ♂ Dorsal view : A. Brachylabic form, B. Macrolabic form,

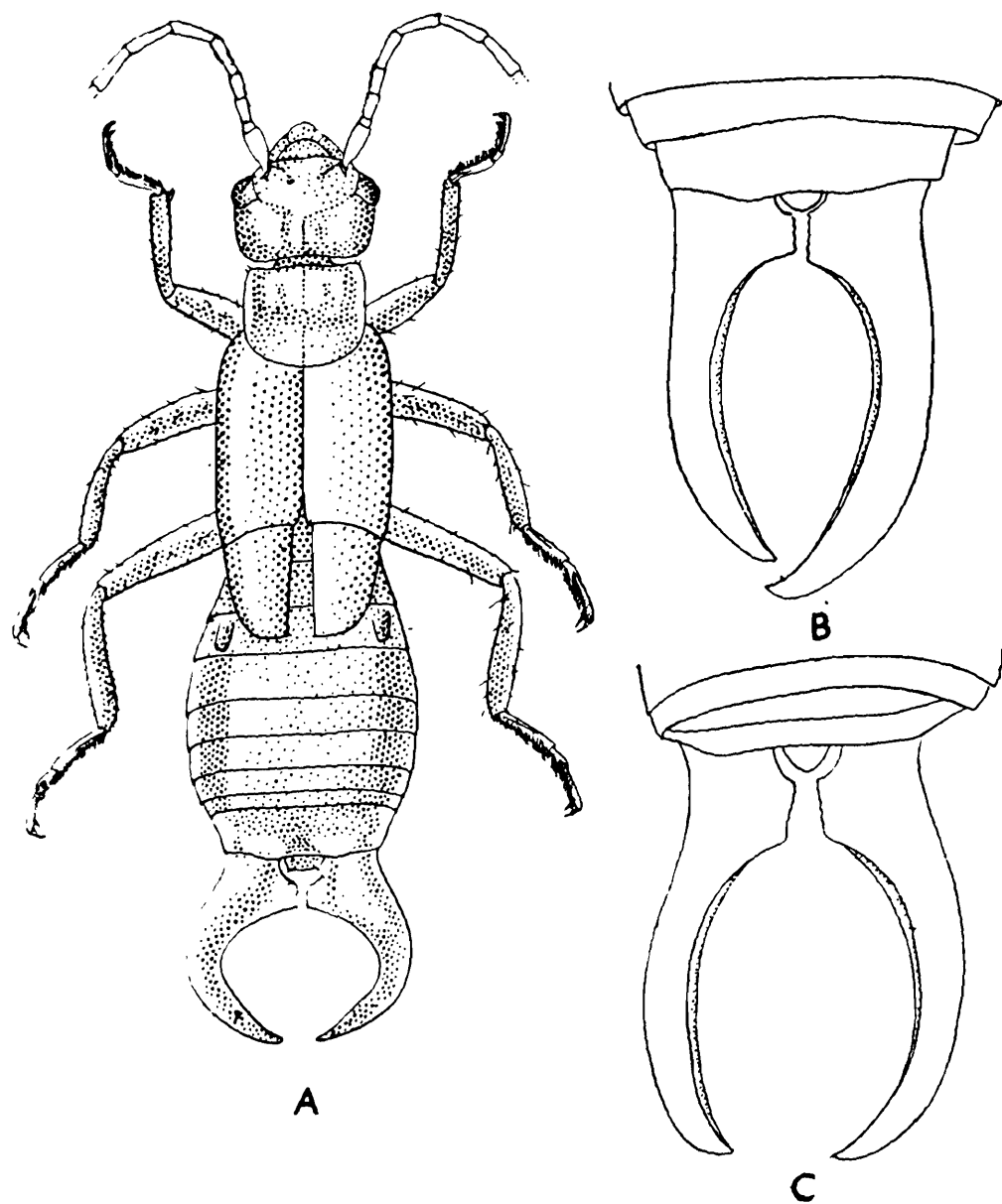


Fig. 11. *Forficula planicollis* (Kirby) ♂ : A. Dorsal view with brachylabial form, B. Ultimate tergite and forceps in mesolabial form, C. Ultimate tergite and forceps in macrolabial form.

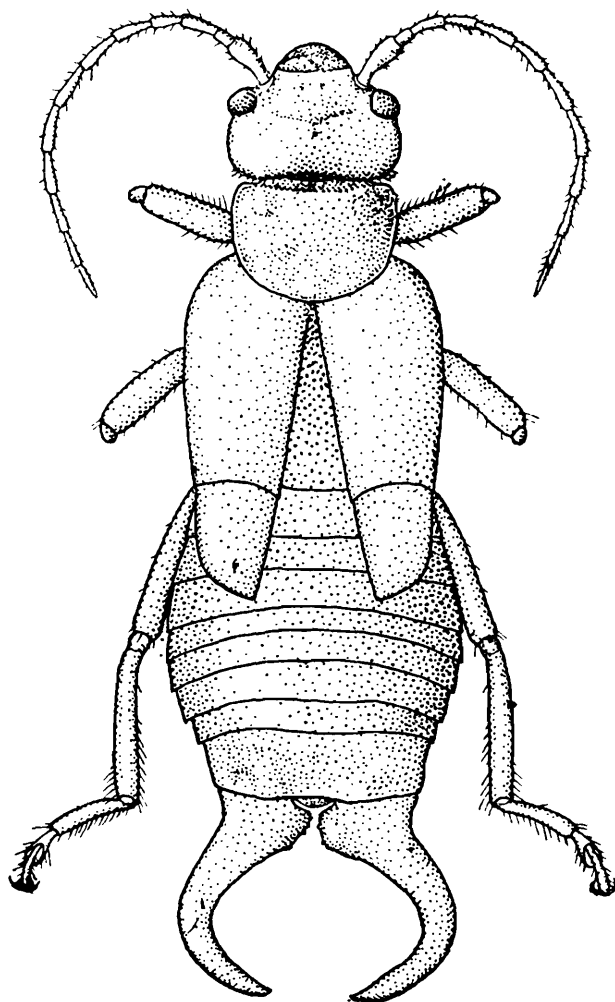


Fig. 12. *Forficula schlagintweiti* (Burr) ♂, Dorsal view.

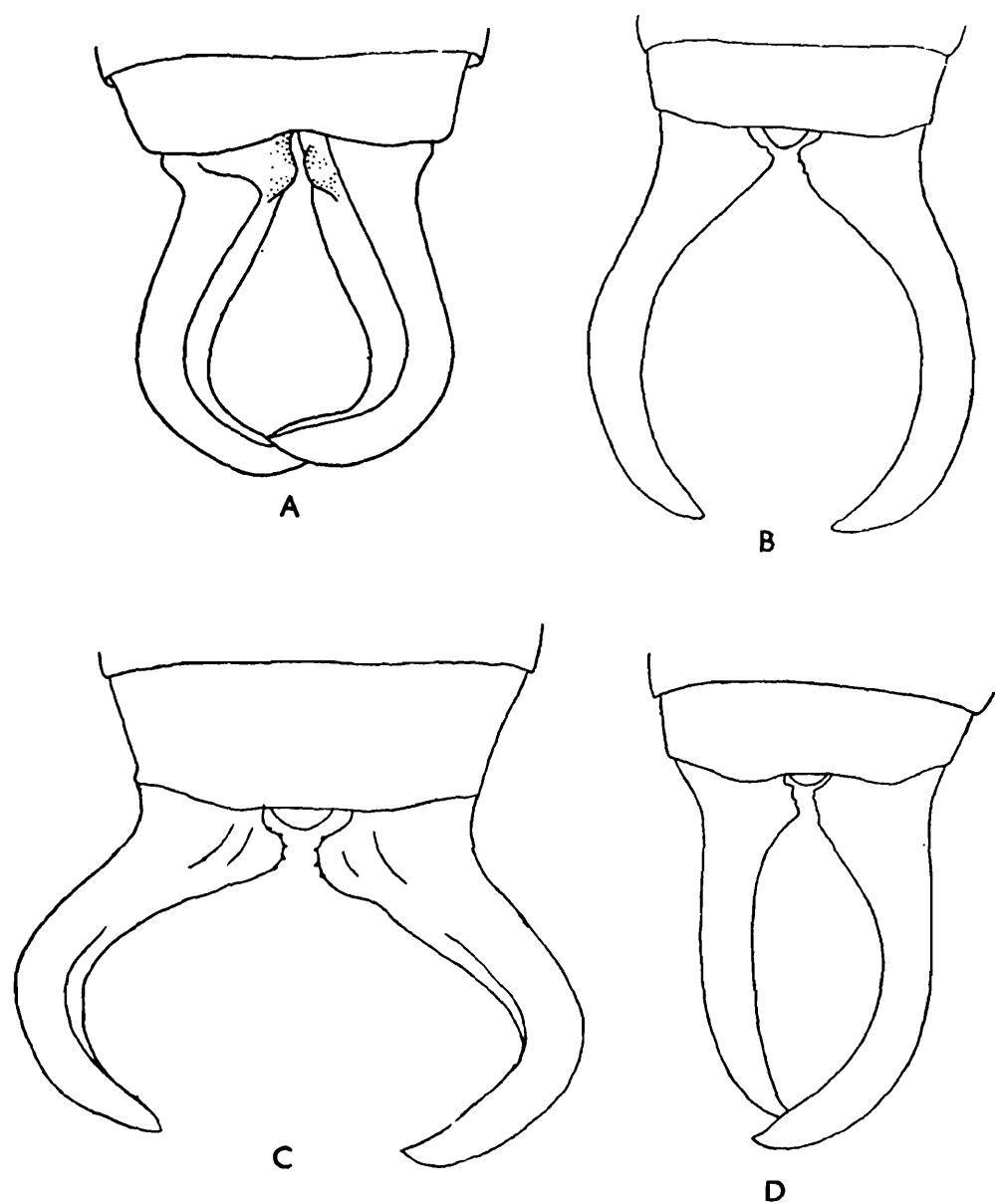


Fig. 13. A-D. *Forficula schlagintweiti* (Burr) ♂, Ultimate tergite and forceps showing variations.

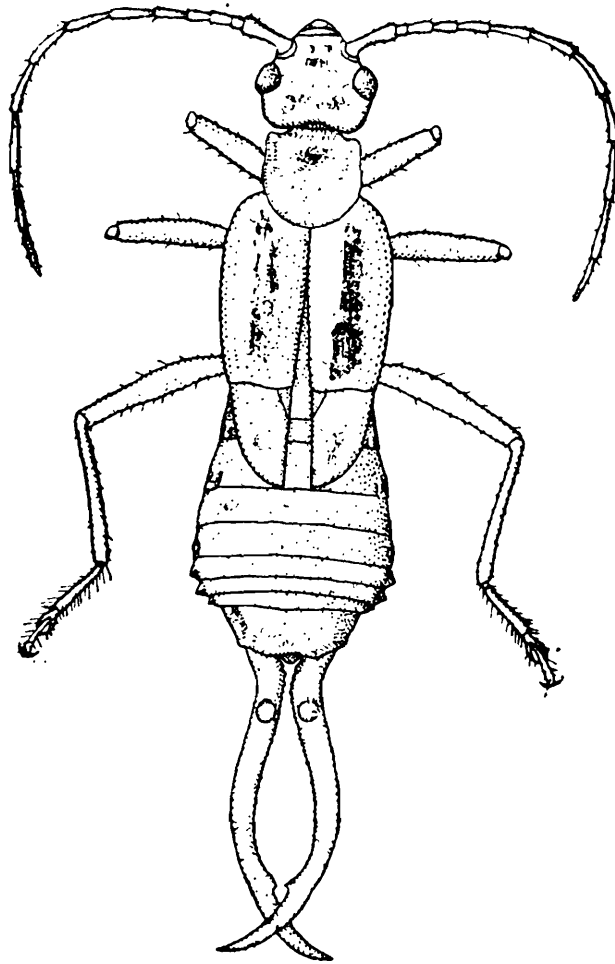


Fig. 14. *Eparchus insignis* (Haan) ♂, Dorsal view with sides of abdominal segments tuberculate and forceps at base with a vertical tubercle.